SELECTED

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RESOURCES

ABSTRACTS

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WATER RESOURCES
ABSTRACTS

VOLUME 23, NUMBER 4
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W90-02545 -- W90-03561

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected **Water Resources Abstracts,** a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several services of the Water Resources Scientific Information Center. The cumulative SWRA file from 1968 and monthly updates are available also in magnetic tape through lease from NTIS.

THE WATER RESOURCES SCIENTIFIC INFOR-MATION CENTER DOES NOT PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
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U.S. Geological Survey
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Reston, VA 22092

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2. WATER CYCLE

2A. General

APPROXIMATING RAINFALL-RUNOFF MODELLING UNCERTAINTY USING THE STOCHASTIC INTEGRAL EQUATION METHOD.
Williamson and Schmid, Irvine, CA.
T. V. Hromadka.
Advances in Water Resources AWREDI, Vol. 12, No.1, p 21-25, March 1989. 3 fig, 19 ref.

Descriptors: *Rainfall-runoff relationships, *Error analysis, *Hydrologic models, *Model studies, *Stochastic process, Catchment areas, Mathematical models, Stochastic hydrology, Probability distribution.

The most recent literature regarding rainfall-runoff hydrologic models has demonstrated the considerable magnitude of uncertainty in modeling predictions. Due to the nondeterministic nature of the rainfall-runoff processes occurring over the catchment, the mathematical descriptions of these processes result in stochastic equations, in which variations about the assumed values are governed by certain probability distributions. It is more realistic to formulate a stochastic model of the modeling error than to assume a totally deterministic model of the rainfall-runoff phenomena which entirely neglects the significant random error contribution. The uncertainty problem is approached by providing a methodology which can be incorporated into almost all rainfall-runoff models. The methodology is based upon the standard theory of stochastic integral equations which has been successfully applied to several problems in the life sciences and chemical engineering. The stochastic integral formulation is used to represent the total variation between a record of measured runoff data and model estimates. Because of the simplicity of the technique, the stochastic integral equation method can be integrated into most currently available rainfall-runoff models. The method provides the capability to develop probability distributions of almost all criterion variable estimates as produced from almost any rainfall-runoff modelling approach. (Fish-PTT)
W90-02547

WATER YIELD FROM FOREST SNOWPACK MANAGEMENT: RESEARCH FINDINGS IN ARIZONA AND NEW MEXICO.
Arizona Univ., Tucson. School of Renewable Natural Resources.
For primary bibliographic entry see Field 4A.
W90-02588

SURFACE HUMIDITY AND PRECIPITABLE WATER VAPOR LINKAGE OVER WEST AND CENTRAL AFRICA: FURTHER CLARIFICATION AND EVALUATION OF EXISTING MODELS.
Obafemi Awolowo Univ., Ile-Ife (Nigeria). Dept. of Physics.
For primary bibliographic entry see Field 7C.
W90-02638

WATER INFILTRATION AS AFFECTED BY SOIL CRUST AND MOISTURE PROFILE.
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
For primary bibliographic entry see Field 2G.
W90-02739

CLIMATE AND WATER RESOURCES.
Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR).
I. A. Shiklomanov.
Hydrological Sciences Journal HSJODN, Vol. 34, No. 5, p 495-529, Oct 1989. 9 fig, 4 tab, 42 ref.

Descriptors: *Climatology, *Greenhouse effect, *Climates, *Global warming, *Water resources development, Anthropogenic effects, Temperature, Carbon dioxide, Interrelations.

River runoff and the resulting water resources which provide the needs of mankind for fresh water are subject to variations in space and time mainly depending on the space and time variability of climate characteristics. Thus there are close interrelations between the problems of the provision of fresh water and the problems of both natural and anthropogenic changes in climate. Moreover, these interrelations are characterized by specific features both under natural conditions and during a period of man's intensive impact on water resources. On the basis of research results obtained at the State Hydrological Institute in Leningrad, the global interrelations between climatic characteristics and water resources under natural conditions have been determined and in the case of intensive water resources development; up-to-date ideas on the anthropogenic changes of the global climate given; and the possible consequent effects on future water resources were analyzed. Changes in climate for the next 40-60 years corresponding to the rise of mean global air temperature by 3-4 C resulting from CO_2 increase in the atmosphere are quite significant, in particular for the middle and high latitudes of the Northern Hemisphere. This will greatly affect the whole variety of physiographic features in vast areas and in entire countries, the future water resources, the conditions of living, the structure and development of economics, and primarily agriculture and water management. (Author's abstract)
W90-02759

ESTIMATION OF THE PARAMETERS OF AN ISOLATED EVENT CONCEPTUAL MODEL FROM PHYSICAL CATCHMENT CHARACTERISTICS.
Rhodes Univ., Grahamstown (South Africa). Dept. of Geography.
D. A. Hughes.
Hydrological Sciences Journal HSJODN, Vol. 34, No. 5, p 539-557, Oct 1989. 4 fig, 5 tab, 31 ref.

Descriptors: *Rainfall-runoff relationships, *Flood forecasting, *Floods, *South Africa, *Model studies, Flood data, Catchment areas.

There has been a trend in recent years towards the development and popularity of physically-based deterministic models. However, the application of such models is not without difficulties. The usefulness of a conceptual single-event model for simulating floods from catchments covering a wide variety of climatic and physiographic areas was investigated using a model that was calibrated on a group of catchments. The calibrated parameter values were then related to physical catchment indices. The resulting quantitative relationships were assessed with respect to their value for estimating the parameter values of the model when calibration is not possible. The results indicate that the technique is likely to provide flood estimations for medium sized catchments (5-150 sq km) that are more reliable than several flood estimation methods currently in use in South Africa. (Author's abstract)
W90-02761

EVAPOTRANSPIRATION IN A GREENHOUSE-WARMED WORLD: A REVIEW AND A SIMULATION.
Resources for the Future, Inc., Washington, DC. Climate Resources Program.
For primary bibliographic entry see Field 2D.
W90-02781

MODELING THE EFFECTS OF AMAZONIAN DEFORESTATION ON REGIONAL SURFACE CLIMATE: A REVIEW.
National Center for Atmospheric Research, Boulder, CO.
For primary bibliographic entry see Field 4C.
W90-02783

FLOOD FORECASTING BY THE FILTER SEPARATION AR METHOD AND COMPARISON WITH MODELING EFFICIENCIES BY SOME RAINFALL-RUNOFF MODELS.
Utsunomiya Univ. (Japan). Dept. of Civil Engi-

neering.
For primary bibliographic entry see Field 2E.
W90-02801

DERIVING THE UNIT HYDROGRAPH BY ROOT SELECTION.
College of Technology, Dublin (Ireland).
For primary bibliographic entry see Field 2E.
W90-02802

DISCRETIZATION AND COST-EFFECTIVENESS OF A FINITE ELEMENT SOLUTION FOR HILLSLOPE SUBSURFACE FLOW.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2E.
W90-02804

SIMULATION OF STREAMFLOW IN SMALL DRAINAGE BASINS IN THE SOUTHERN YAMPA RIVER BASIN, COLORADO.
Geological Survey, Denver, CO. Water Resources Div.
R. S. Parker, and J. M. Norris.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4071, August 1989. 47p, 14 fig, 11 tab, 8 ref.

Descriptors: *Model studies, *Runoff forecasting, *Simulation, *Rainfall-runoff relationships, *Colorado, Calibrations, Streamflow forecasting, Soil water.

Coal mining operations in northwestern Colorado commonly are located in areas that have minimal available water-resource information. Drainage-basin models can be a method for extending water-resource information to include periods for which there are no records or to transfer the information to areas that have no streamflow-gaging stations. To evaluate the magnitude and variability of the components of the water balance in the small drainage basins monitored, and to provide some method for transfer of hydrologic data, the U.S. Geological Survey's Precipitation-Runoff Modeling System was used for small drainage basins in the southern Yampa River basin to simulate daily mean streamflow using daily precipitation and air-temperature data. The study area was divided into three hydrologic regions, and in each of these regions, three drainage basins were monitored. Two of the drainage basins in each region were used to calibrate the Precipitation-Runoff Modeling System. The model was not calibrated for the third drainage basin in each region; instead, parameter values were transferred from the model that was calibrated for the two drainage basins. For all of the drainage basins except one, period of record used for calibration and verification included water years 1976-81. Simulated annual volumes of streamflow for drainage basins used in calibration compared well with observed values; individual hydrographs indicated timing differences between the observed and simulated daily mean streamflow. Observed and simulated annual average streamflows compared well for the periods of record, but values of simulated high and low streamflows were different than observed values. Similar results were obtained when calibrated model parameter values were transferred to drainage basins that were uncalibrated. (USGS)
W90-02856

HYDROGEOLOGY.
For primary bibliographic entry see Field 2F.
W90-02866

HISTORICAL PERSPECTIVE.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2F.
W90-02867

HYDROGEOLOGIC SETTING OF REGIONS.
Geological Survey, Raleigh, NC.
For primary bibliographic entry see Field 2F.
W90-02869

REGION 7, CENTRAL ALLUVIAL BASINS.
Geological Survey, Tucson, AZ.
T. W. Anderson, G. E. Welder, G. Lesser, and A. Trujillo.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 81-86. 2 fig, 15 ref.

Descriptors: *Central Alluvial Basins, *Groundwater depletion, *Arid lands, *Geohydrology, *Geohydrologic units, *Alluvial aquifers, Alluvial plains, Mountains, Basins, Igneous rocks, Sedimentary rocks, Metamorphic rocks, Arid climates, Semiarid climates, Groundwater recharge, Precipitation, Surface water availability, Water storage, Water resources development, Geologic units, Geologic control, North America.

The Central Alluvial Basins of North America encompass about 700,000 square kilometers in southwestern United States and north-central Mexico. The land form of the area is characteristic of basin-and-range physiography with sharply rising mountains separated by broad alluvial plains. Mountains have a general north-to-northwest trend and divide the area into many basins. Rocks in the Central Alluvial Basins region include igneous, metamorphic, and sedimentary types. The region is the driest area in the United States and Mexico, and large areas are classified as arid and semiarid. Water resources in the region are derived from precipitation or from surface-water inflow. The limited surface-water resources of the area are almost completely appropriated and generally have been overexploited, so that severe depletion of storage has occurred in many basins. Continued exploitation of groundwater resources at present rates, therefore, eventually will deplete the recoverable volume of stored water. (See also W90-02866) (Fish-PTT)
W90-02876

REGION 8, SIERRA MADRE OCCIDENTAL.
Comision Federal de Electricidad, Mexico City.
J. J. Carrillo.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 87-88. 3 ref.

Descriptors: *Sierra Madre Occidental, *Mexico, *Geohydrology, *Geohydrologic units, Geologic units, Geologic control, Topography, Mountains, Structural geology, Rainfall, River basins, Watersheds, Permeability, Flow control, Dams, Water conservation, Water use, Igneous rocks, Aquitards, Humid climates, Arid climates.

The Sierra Madre Occidental is a mountainous chain essentially parallel to the west coast of Mexico, and is characterized by a high plateau of extrusive rocks with wide structural depressions striking north-northwest to south-southeast; among the gently sloping mountains are mesas and minor plateaus. The climate ranges from humid temperate, with rainfall occurring all year in the higher parts of the Sierra, to a dry steppe climate to the east in the lower parts of the Sierra. The precipitation of the Sierra Madre Occidental is principally of the orogenic type. The rivers that discharge in the Pacific are virtually perennial and drain basins of great length. The large amount of water that drains the Pacific watershed results from high rainfall on rocks with a wide range of permeability. All the important rivers have dams to control the flow and to achieve maximum water conservation and usage. The topography of the region is formed principally by dissection of igneous rocks. Low-permeability rocks that occur throughout the geologic section compose regional aquitards. (See also W90-02866) (Fish-PTT)
W90-02877

REGION 10, FAJA VOLCANICA TRANSMEXICANO.
Secretaria de Agricultura y Recursos Hidraulicos, Mexico City. Subdireccion Geohidrologia.
R. Chavez.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 93-98. 5 fig.

Descriptors: *Geohydrology, *Geohydrologic units, *Groundwater movement, *Mexico, *Transmexican Volcanic Belt, Geologic units, Geologic control, Topography, Geohydrologic boundaries, River basins, Hydraulic properties, Geochemistry, Mountains, Volcanoes, Valleys, Arroyos, Drainage, Humid climates, Subhumid climates, Arid climates, Flow discharge, Physiographic provinces, Structural geology.

The Faja Volcanica Transmexicano (Transmexican Volcanic Belt) hydrogeologic region is approximately coincident with the physiographic province of the same name in central Mexico. The region is predominantly mountainous and composed of some of the most extensive and spectacular manifestations of volcanism in North America. Other relevant physiographic features are the lacustrine valleys between the mountain chains. Numerous rivers and arroyos drain this region. The dominant climates are tropical and humid-temperate, subhumid temperate and arid temperate, and humid-to-arid cold. Lithologically, the oldest igneous rocks that form the mountains are essentially impermeable; nevertheless, those that have been tectonically fractured or altered by weathering may have significant permeability. Rocks of high infiltration capacity are vesicular basalts, columnar basalts, and thick pyroclastics whose outcrops are excellent recharge areas. Frequently in elevated mountainous areas, fractured and altered rocks overlie less-permeable rocks and form perched aquifers independent of the regional system. On passing through rocks of basaltic composition, predominant in the recharge area, water gains cations of Ca and Mg from the dissolution of calcic feldspars and ferromagnesian minerals. In lacustrine valleys, the water salinity is relatively high owing to long residence time in the subsurface and its frequent circulation through or near evaporites; dissolved solids here are commonly greater than 1000 mg/L. Infiltrating water that reaches great depths and circulates close to volcanic and tectonic heat sources transports and redistributes the heat, forming convective hydrothermal systems. The more important geothermal systems are in the western portion of the region. Thermal processes are usually associated with the upward heat flow from depth and include the effects of magma chambers. (See also W90-02866) (Fish-PTT)
W90-02879

REGION 23, GULF OF MEXICO COASTAL PLAIN.
Geological Survey, Austin, TX.
H. F. Grubb, and J. J. Carillo.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 219-228. 8 fig, 1 tab, 19 ref.

Descriptors: *Geohydrology, *Geohydrologic units, *Aquifer systems, *Coastal plains, Geologic time, Cenozoic era, Mesozoic era, Sedimentary rocks, Oil, Fluid mechanics, Saline water, Geohydrologic boundaries, Geologic units, Physiographic provinces, Permeability, Groundwater recharge, Deposition, Topography, Groundwater movement, Precipitation, Louisiana, Texas, Mexico.

The Coastal Plain Physiographic Province of the south-central United States and eastern Mexico is a gently rolling to flat region of about 670,000 sq km, underlain by a gulfward-thickening wedge of unconsolidated to semiconsolidated sedimentary rocks of Cenozoic age which overlie rocks of Mesozoic age. Many regional aquifers have developed in these sediments. The older Coastal Plain sediments of Cretaceous age in Mexico predominantly are rocks of marine origin with minimal permeability. Where significant permeability occurs in these rocks, the contained fluids are typically saline water or oil. A zone of abnormally high fluid pressure (geopressure) has developed onshore in sediments of Eocene age in parts of coastal Louisiana, Texas, and Mexico. The top of geopressure or the transition from normal hydrostatic pressure to abnormally high pressure is considered the base of the groundwater flow system. The complex sequence of Tertiary rocks is divided into four major hydrogeologic units in the United States and northeastern Mexico on the basis of

sediment age and the predominant depositional environment. Precipitation, the ultimate source of all recharge to the sediments of the western Gulf Coastal Plain, varies on an annual basis, increasing gradually southward. In areas with an abundant supply of precipitation, predevelopment groundwater flow patterns primarily are controlled by topography, permeability, and the geometry of the aquifers. The water becomes increasingly saline downdip toward the Gulf of Mexico. (See also W90-02866) (Fish-PTT)
W90-02892

NATURE OF COMPARATIVE HYDROGEOLOGY.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
S. N. Davis.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 271-272. 12 ref.

Descriptors: *Geohydrology, *Geohydrologic units, *Comparison studies, Geohydrologic boundaries, Physiographic provinces, Permeability, Rock properties, Groundwater recharge, Geochemistry, Topography, Precipitation, Carbon dioxide, Model studies, Waste management, Hydrologic maps, Land use, Prediction, Geologic mapping, Topographic mapping, Regional planning.

The term 'comparative hydrogeology' was first used to include topography, precipitation, rock type, availability of recharge rich in carbon dioxide, and other factors. A discussion may be based on a comparison primarily of rock types. Within the past ten years, the need to model hypothetical repositories for radioactive waste and the desire to construct hydrogeologic maps for land use planning have stimulated new interest in comparative hydrogeology. Comparative hydrogeology helps to fill at least three general needs for the professional hydrologist. First, it allows predictions to be made of expected hydrogeologic conditions based on geologic and topographic information. Second is the development of the ability to recognize hydrogeologic anomalies. Third, comparative studies are essential for many purposes of regional or local land-use planning. No substitute exists for detailed, site-specific investigations for most engineering projects. (See also W90-02866) (Fish-PTT)
W90-02898

ALLUVIAL AQUIFERS ALONG MAJOR RIVERS.
Texas Univ. at Austin. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2E.
W90-02899

WESTERN ALLUVIAL VALLEYS AND THE HIGH PLAINS.
For primary bibliographic entry see Field 2F.
W90-02900

GLACIAL DEPOSITS.
Dames and Moore, Phoenix, AZ.
For primary bibliographic entry see Field 2F.
W90-02901

GROUND WATER AS A GEOLOGIC AGENT.
Texas A and M Univ., College Station. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-02907

LANDFORM DEVELOPMENT.
California Univ., Davis. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-02908

LANDFORM DEVELOPMENT; KARST.
McMaster Univ., Hamilton (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2F.

W90-02909

GROUND WATER AND CLASTIC DIAGENESIS.
Alberta Univ., Edmonton. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-02910

APPLICATIONS OF REMOTE SENSING IN HYDROLOGY.
Agricultural Research Service, Beltsville, MD. Hydrology Lab.
T. Schmugge, and R. J. Gurney.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 383-388, 13 ref.

Descriptors: *Hydrology, *Soil water, *Remote sensing, Satellite technology, Hydrologic models, Data acquisition, Soil temperature, Microwaves, Insolation, Energy equation.

Remote sensing has the capability of repeatedly observing several variables of hydrologic interest over large areas. These variables include surface soil moisture, surface temperature, albedo/land cover, snow water equivalent, and snow cover area. With the possible exception of the last of these, there has not been extensive use of remote sensing in hydrologic models. Microwave radiometers measure the thermal emission coming up from the soil, which is proportional to the physical temperature of the soil, with the constant of proportionality being the emissivity of the soil, which depends very strongly on the moisture content. Other factors affecting the microwave emission from the soil surface include soil texture, surface roughness, and vegetation cover. Three conditions are necessary for evapotranspiration to occur: (1) the energy for a change of phase of water; (2) a sources of water (i.e., adequate soil moisture in the surface layer or in the root zone of the plant); and (3) a sink for the water (i.e., a moisture deficit in the air above the surface). Remote sensing can contribute to all of these factors by enabling estimates of a number of surface and boundary-limited parameters. These include: incoming solar radiation, surface albedo, vegetation cover, surface temperature, atmospheric temperature and water vapor, and surface soil moisture. Most of the approaches using surface temperature observations rely on the solution to the energy balance equation. Remotely sensed data are essential for global and continental applications for which useful estimates of hydrologic parameters can be made. (See also W90-02980) (Rochester-PTT)
W90-03035

COMPUTATIONAL METHODS IN WATER RESOURCES, VOL.2: NUMERICAL METHODS FOR TRANSPORT AND HYDROLOGIC PROCESSES.
Proceedings of the VII International Conference, MIT, Cambridge, Massachusetts, June 1988. Elsevier, New York. 1988. Co-published with Computational Mechanics Publications, Boston. Developments in Water Science No. 36. Edited by M.A. Celia, et al. 466p.

Descriptors: *Model studies, *Surface water, *Groundwater, *Mathematical models, *Mathematical studies, *Computer models, Mathematical equations, Symposium, Surface-groundwater relations, Solute transport, Saturated flow, Unsaturated flow, Porous media, Hydrodynamics, Hydrology, Heat transfer, Chemical reactions, Simulation.

This book forms part of the edited proceedings of the Seventh International Conference on Computational Methods in Water Resources, held at the Massachusetts Institute of Technology in June 1988. A wide variety of problems in surface and sub-surface hydrology are addressed, including: numerical methods for transport, computational fluid dynamics, numerical analysis, solute transport

in saturated porous media, solute transport in unsaturated porous media, chemical processes, heat transport, general hydrology, parameter estimation, optimization, and software developments. (See W90-03037 thru W90-03103) (Rochester-PTT)
W90-03036

ALTERNATIVE WAYS OF TREATING DOMAIN INTEGRALS IN BOUNDARY ELEMENTS.
Southampton Univ. (England). Computational Mechanics Inst.
For primary bibliographic entry see Field 7C.
W90-03055

NON LINEAR INSTABILITY IN LONG TIME CALCULATIONS OF A PARTIAL DIFFERENCE EQUATION.
Dundee Univ. (Scotland). Dept. of Mathematics and Computer Science.
For primary bibliographic entry see Field 7C.
W90-03058

NUMERICAL TREATMENT OF PARTIAL DIFFERENTIAL EQUATIONS BY THE PARALLEL APPLICATION OF A HYBRID OF THE RITZ-, GALERKIN-PRODUCT INTEGRAL METHODS.
Wisconsin Univ.-Green Bay. Dept. of Mathematics.
For primary bibliographic entry see Field 7C.
W90-03059

FRACTIONAL STEPS AND PROCESS SPLITTING METHODS FOR INDUSTRIAL CODES.
CEFRHYG, Grenoble (France).
For primary bibliographic entry see Field 7C.
W90-03060

CONSTRUCTION OF N-TH ORDER FUNCTIONS FOR COMPLETE INTERPOLATION.
Mississippi Univ., University. School of Engineering.
For primary bibliographic entry see Field 7C.
W90-03061

SOME CONSIDERATIONS ABOUT THE SIMULATION OF KARSTIC AQUIFERS.
Granada Univ. (Spain). Dept. of Geodynamic.
For primary bibliographic entry see Field 2F.
W90-03108

DETERMINATION OF THE CATCHMENT AREAS IN KARST.
Split Univ. (Yugoslavia). Faculty of Civil Engineering Sciences.
O. Bonacci.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 606-611, 4 fig, 4 ref.

Descriptors: *Model studies, *Geohydrology, *Surface-groundwater relations, *Karst hydrology, *Catchment areas, Karst, Mathematical models, Quantitative analysis, Hydrologic budget, Hydrologic models, Yugoslavia.

The determination of the exact catchment boundaries and area of springs and rivers in karst, is a very difficult and complex problem due to a strong, direct and complex interaction between groundwater and surface water in karst. An approach to the solution of that problem uses geohydrological and hydrological quantitative methods and models. All analyses need to take into account the fact that the catchment area may vary in time depending on the groundwater levels. The following methods can be used for the determination of the catchment area: (1) Hydrologic budget method; (2) Groundwater hydrograph method; (3) and Hydrological models (Stanford watershed model, and SSAAR). The variations of catchment

areas are defined by analyzing the recession part of a spring hydrograph. The testing of the methods was performed on several catchments in the Yugoslav karst. (See also W90-03104) (Author's abstract)
W90-03111

HYDROLOGICAL DEFINITION OF KARST AREAS.
Sarajevo Univ. (Yugoslavia). Inst. of Water Resources Engineering.
For primary bibliographic entry see Field 2F.
W90-03112

SOME NEW IDEAS ON THE PREDICTION OF TUNNEL INFLOW IN KARST AREA BY WATER BALANCE METHOD.
Second Inst. of Railway Survey and Design, Chengdu (China).
J. Zhang, and G. Chen.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 691-700, 5 fig.

Descriptors: *Karst hydrology, *Tunnel inflow, *Mathematical studies, Tunnel hydraulics, Hydrologic budget, Rainfall-runoff relationships, Groundwater recharge, Infiltration, Geologic fractures, Percolation.

Some new ideas are presented concerning the prediction of tunnel inflow in karst areas and, in particular, in the vertical percolating zone, using the water balance method. Discussions focus on: catchment and watershed areas; non-linear relationships between rainfall and infiltration capacity; critical rainfall; the non-linear characteristics of percolation; interrelation of percolation amount and tunnel inflow; inflow coefficient; and computation and segmentation of tunnel inflow. Based on the results of practical work on many long tunnels in China, the various segments of karst tunnel inflow may include: the tract of intensive karstification; the tract of depression; the tectonic fracture zone; and the contact zone between soluble and insoluble rocks. (See also W90-03104) (Lantz-PTT)
W90-03122

ENVIRONMENTAL ISOTOPIC STUDIES OF KARST WATER SYSTEM OF THE GUOZHUANG SPRINGS, SHANXI, CHINA.
China Univ. of Geosciences, Wuhan, Hubei, China.
For primary bibliographic entry see Field 2F.
W90-03138

OPTIMAL REAL-TIME FORECASTING AND CONTROL OF RESERVOIR HYDROSYSTEMS USING REMOTE AND ON-SITE SENSORS, VOLUME I: FORECASTING RESERVOIR INFLOWS.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
K. P. Georgakakos, T. H. Lee, and H. Shen.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109356/AS, price codes: A11 in paper copy, A01 in microfiche. Final Report, August 1989. 212p, 84 fig, 15 tab, 70 ref. USGS Contract 14-08-0001-G1297.

Descriptors: *Water storage, *Reservoir operation, *Reservoir storage, *Forecasting, *Model studies, Reservoir systems, Optimization, Remote sensing, Hydrometeorological models, Simulation analysis, Rainfall prediction, Algorithms.

Fulfillment of the objectives of reservoir systems depends critically upon the successful management of the naturally uncertain river flows. The reservoir-system control study is viewed as a two-step process: first, a valid model is developed that utilizes all available hydrometeorological data and reproduces the system's hydrometeorological response, reliably; second, an efficient optimization algorithm (controller) is designed to guide the model, and thereby the actual system, in success-

fully meeting its operational objectives. Reservoir-system management is viewed as a combined effort drawing on hydrologic as well as on operations research advances. The key components of the hydrometeorological model studied for the simulation of the reservoir-system response were a physically-based two-dimensional rainfall prediction model; a soil moisture accounting model; channel routing models suitable for application to headwater catchments and to flood plains; and a state estimator that utilizes, in real-time, all available hydrometeorological data and produces (a) updates of the model states, and (b) estimates of prediction uncertainty. (See also W90-03553) (USGS)
W90-03552

OPTIMAL REAL-TIME FORECASTING AND CONTROL OF RESERVOIR HYDROSYSTEMS USING REMOTE AND ON-SITE SENSORS, VOLUME II: RESERVOIR-SYSTEM CONTROL.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
A. P. Georgakakos.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109364/AS, price codes: A09 in paper copy, A01 in microfiche. Final Report, August 1989. 175p, 77 fig, 23 tab, 86 ref, 4 append.

Descriptors: *Model studies, *Reservoir systems, *Water storage, *Reservoir storage, Optimization, Algorithms, Forecasting, Stochastic control method, Reservoir operation, Savannah River system.

Fulfillment of the objectives of reservoir systems depends critically upon the successful management of the naturally uncertain river flows. The reservoir-system control study is viewed as a two-step process: first, a valid model is developed that utilizes all available hydrometeorological data and reproduces the system's hydrometeorological response, reliably; second, an efficient optimization algorithm (controller) is designed to guide the model, and thereby the actual system, in successfully meeting its operational objectives. Reservoirs-system management is viewed as a combined effort drawing on hydrologic as well as on operations research advances. The key components of the reservoir control scheme studied were the extended linear quadratic Gaussian (ELOG) control algorithm for the optimal operation of the multiobjective reservoirs with (a) the ability to handle non-Gaussian reservoir input, and (b) an enhanced barrier-function method to efficiently handle reliability storage constraints; and a stochastic control method for the real-time operation of hydropower systems, which finds optimal hydropower schedules by invoking several control levels. (See also W90-03552) (USGS)
W90-03553

2B. Precipitation

SIMPLE PERTURBATION MODEL FOR THE ELECTROSTATIC SHAPE OF FALLING DROPS.
Illinois Univ. at Urbana-Champaign. Dept. of Atmospheric Sciences.
K. V. Beard, J. Q. Feng, and C. Chuang.
Journal of the Atmospheric Sciences JAHSAK, Vol. 46, No. 15, p 2404-2418, August 1, 1989. 12 fig, 6 tab, 27 ref.

Descriptors: *Atmospheric physics, *Rain, *Electric fields, *Particle shape, *Fluid drops, Pressure-measuring instruments, Laplace equation, Wind, Thunderstorms, Mathematical analysis, Lightning.

The shape of drops in the presence of electric forces has been the subject of numerous investigations having applications as diverse as raindrops in thunderstorms and ink-jet printing. A perturbation model for the shape of falling drops in the presence of electric fields and charges was developed by extension of previous methods that includes aerodynamic effects in the pressure balance equation of Laplace. Use of a consistent first-order perturbation equation and spherical harmonics helped to reconcile apparent inconsistencies in the cosine series method originated by Savic. Calculated axis ratios were consistent with wind tunnel observations for non-oscillating drops in vertical electric fields, and generally agreed with the numerical findings of Chuang for electrostatic-aerodynamic shapes. Results indicate detectable shape changes in thunderstorms--produced directly by strong electric fields, but modified considerably by changes in fall speed, with and without charges. The most favorable situation appears to be in vertical fields just before initiation of lightning. (Author's abstract)
W90-02566

RAINDROP COLLISION RATES.
McGill Univ., Montreal (Quebec). Dept. of Meteorology.
R. R. Rogers.
Journal of the Atmospheric Sciences JAHSAK, Vol. 46, No. 15, p 2469-2472, August 1, 1989. 3 fig, 18 ref.

Descriptors: *Rain, *Cloud physics, *Fluid drops, *Rainfall simulators, *Atmospheric physics, *Particle size, Rainfall disposition, Distribution patterns, Laboratories, Coalescence, Radar, Growth rates, Equilibrium.

A subject of continuing interest in cloud physics is the evolution of the drop-size distribution of rain. Recent interest in this subject has been stimulated by improved laboratory measurements of drop breakup and the sizes of the fragments produced. A fundamental quantity underlying the evolution of raindrop spectra is the rate at which the drops collide with one another. An upper estimate can be obtained analytically for the raindrop collision rate for a plausible model spectrum, as a function of the radar reflectivity or the rainwater content. The rate of collisions experienced by the average raindrop increases with increased reflectivity factors. Only a small fraction of the total number of collisions cause breakup; most lead to coalescence. The smallest drops in the distribution account for many of the collisions in these calculations, and these are the drops for which the likelihood of breakup is the smallest. Some of these collisions cause disruption of the drops and limit their rate of growth. However, the large drops are so sparse that the numbers of fragments produced per unit volume may still be small compared with the total number of drops already present. These simple calculations do not answer the question of the time needed to achieve an equilibrium raindrop spectrum, but they do underline the improbability of achieving breakup-controlled equilibrium distributions in realistic times except perhaps in intense rain. (Fish-PTT)
W90-02567

GOES SATELLITE DATA IN RAINFALL ESTIMATION.
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
S. F. Shih.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 115, No. 5, p 839-852, October 1989. 4 fig, 2 tab, 26 ref, append.

Descriptors: *Remote sensing, *Meteorological data collection, *Model studies, Data acquisition, *Hydrologic models, *Satellite technology, Infrared imagery, Rainfall distribution, Rainfall rate, Rain gages, Model studies, Florida, Water resources development.

Rainfall data constitute an important parameter for studying water-resources-related problems. Particularly, the determination of the amount of rainfall on an area of interest is fundamental to many hydrologic studies. Geostationary Operational Environmental Satellite (GOES) visible and thermal infrared data, in conjunction with the Griffith-Woodley method, are used to estimate the rainfall in Florida. Both the life history techniques (LHT) and streamline techniques (SLT) of the Griffith-Woodley method are studied. The results show that the satellite data are useful for estimating both the volume and areal distribution of rainfall, which are very difficult to assess using the conventional rain-gage method. The satellite rainfall estimation is well-correlated with the gage rainfall measurement. The coefficients of determination range from 0.76 to 0.82 in the LHT and from 0.56 to 0.60 in the SLT. The paired t-test is able to differentiate the performance difference between the LHT and SLT, and the rainfall estimated by the LHT was significantly higher than that by the SLT. The LHT appears to be more suitable for estimating rainfall under Florida conditions, mainly because of the rainfall increment rate between the satellite estimation and gage measurements is near 1.0 in the LHT but not in the SLT. A further study is strongly recommended concerning the possibility of improving the SLT application. (Author's abstract)
W90-02573

SAMPLING PROPERTIES OF PARAMETER ESTIMATORS FOR A STORM FIELD RAINFALL MODEL.
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
For primary bibliographic entry see Field 7B.
W90-02593

ANALYSIS OF FOG SAMPLES FOR PCDD AND PCDF.
Battelle Columbus Div., OH.
For primary bibliographic entry see Field 5B.
W90-02611

DIURNALLY VARYING REGIONAL CLIMATE SIMULATIONS.
Commonwealth Scientific and Industrial Research Organization, Aspendale (Australia). Div. of Atmospheric Research.
For primary bibliographic entry see Field 7C.
W90-02635

TOPOGRAPHICAL AND COASTAL INFLUENCE OF SPATIAL PRECIPITATION PATTERNS IN TUNISIA.
Lund Univ. (Sweden). Dept. of Water Resources Engineering.
R. Berndtsson.
International Journal of Climatology IJCLEU, Vol. 9, No. 4, p 357-369, July/August 1989. 7 fig, 30 ref.

Descriptors: *Climatology, *Meteorology, *Correlation analysis, *Precipitation, *Rainfall distribution, *Tunisia, *Rainfall area, Spatial distribution, Weather, Seasonal variation, Topography, Statistical analysis, Mathematical studies.

The correlation analysis of daily rainfall in Trinisia over a 5-yr period has permitted a measure of spatial dependence in an area with extreme spatial and temporal variability, as influenced by large-scale wind circulation, the topography, and coast. The general spatial correlation pattern was seen to vary with the season, particularly in the areas south of the High Tell and the High Steppes. A spatial pattern as reflected by the generalized correlation field could be drawn for most of the months and subgroups during the wet period. The summer period, however, displays a larger variability and more seldom any discernible correlation pattern. For the months with a distinct spatial correlation pattern, the correlation structure was seen to be markedly anisotropic as influenced by the topography and the coast. These two factors seem to influence the correlation pattern differently during different months. The mean areas within the 0.7 correlation isoline for all subgroups vary from about 1000 sq km in the early autumn to about 7000 sq km in the winter months. (Friedmann-PTT)
W90-02636

HEAVY RAINFALLS OVER EAST ASIA.
Tokyo Univ. (Japan). Dept. of Geography.
J. Matsumoto.
International Journal of Climatology IJCLEU, Vol. 9, No. 4, p 407-423, July/August 1989. 7 fig, 25 ref.

Descriptors: *Climatology, *Meteorology, *Precipitation, *Rainfall intensity, *Rainfall, *Asia, *Monsoons, *Rainfall distribution, Climates, Seasonal variation, Weather, Meteorological data collection, China, Japan, Korea, USSR.

The mean annual and monthly frequency distribution of heavy rainfalls for the period 1971-1980 were investigated over the whole of East Asia, including Japan, China, Korea, USSR, and Hong Kong. The highest frequency region (> 10 times per year) is located along the southern coast of Japan. The second highest region (> 8 times per year) is located along the southern coast of China. The high-frequency area advances northward over China during the summer monsoon season, in accordance with the northward advance of the 'Mei-yu frontal zone.' Maps of the axes of high-frequency heavy rainfall areas (frequency per 10-day period) and of maximum-frequency 10-day periods at each station, clearly reveal the intra-seasonal shift of the heavy rainfall area during the summer monsoon season. According to the dominant causes of heavy rainfalls, four regions are identified. The investigated area is also divided into three regions (I-III) with respect to the annual frequency distribution of heavy rainfalls. Based on these regional divisions, the northern limit of the influence of the 'Mei-yu-front' is determined in terms of heavy rainfall occurrence. (Author's abstract)
W90-02637

SURFACE HUMIDITY AND PRECIPITABLE WATER VAPOR LINKAGE OVER WEST AND CENTRAL AFRICA: FURTHER CLARIFICATION AND EVALUATION OF EXISTING MODELS.
Obafemi Awolowo Univ., Ile-Ife (Nigeria). Dept. of Physics.
For primary bibliographic entry see Field 7C.
W90-02638

TRIALS USE OF A WEIGHING TIPPING-BUCKET RAIN GAUGE.
Meteorological Office, Aberporth (Wales).
For primary bibliographic entry see Field 7B.
W90-02639

THERMODYNAMIC INDICES FOR FORECASTING THUNDERSTORMS IN SOUTHERN SWEDEN.
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping.
T. Andersson, M. Andersson, C. Jacobsson, and S. Nilsson.
Meteorological Magazine MTMGA5, Vol. 118, No. 1404, p 141-146, July 1989. 4 fig, 2 tab, 11 ref.

Descriptors: *Meteorology, *Storms, *Weather forecasting, *Atmospheric physics, *Sweden, *Cloudbursts, *Rainfall, *Precipitation, Statistical methods, Regression analysis, Thermodynamics, Performance evaluation.

Several verification scores were used to investigate the performance of three thermodynamic indices as summertime thunderstorm predictors. They are most efficient during the afternoon, when the 'best' index has a probability of detection of 100%. Combinations of two indices give better scores than single ones. Forward step-wise regression was used to select the best predictors and estimate the lightning frequency. The analyses show a significant correlation between some indices and the frequency of lightning. Nomograms for estimating lightning probabilities and frequencies are suggested. (Author's abstract)
W90-02640

SENSITIVITY OF FINE-MESH RAINFALL AND CLOUD FORECASTS TO THE INITIAL SPECIFICATION OF HUMIDITY.
Meteorological Office, Bracknell (England).
R. S. Bell, and O. Hammon.
Meteorological Magazine MTMGA5, Vol. 118, No. 1404, p 152-158, July 1989. 6 fig, 9 ref.

Descriptors: *Meteorology, *Humidity, *Model studies, *Precipitation, *Rainfall, *Atmospheric

water, *Weather forecasting, Clouds, Air circulation.

The problems associated with the objective analysis of humidity are reviewed. A technique for amending the initial fine-mesh humidity fields results in close agreement between the fine-mesh model cloud analysis and satellite imagery. Three case studies, one frontal, one of wave development, and one of anticyclonic stratocumulus illustrate the impact of the amended initial moisture fields on subsequent cloud and rainfall forecasts. The relatively simple technique, involving the 'painting over' of the model relative humidity field after the assimilation stage, can result in a significant impact on the forecast rainfall on most occasions and also a noticeable impact on model cloud on some occasions when a problem with the initial moisture field has been noted. The frontal case showed that the impact is greater in the first day and less towards the end of the forecast, where, presumably, evolution errors begin to dominate. The wave development case showed that erroneous waves can be suppressed. The impact in the anticyclonic case is less predictable, with the main signal appearing to be that some impact is obtained as long as the model's inversion is not too low and the additional moisture is inserted over sea points. (Friedmann-PTT)
W90-02641

CONDENSATION AND CLOUD PARAMETERIZATION STUDIES WITH A MESOSCALE NUMERICAL WEATHER PREDICTION MODEL.
Bergen Univ. (Norway). Dept. of Meteorology.
For primary bibliographic entry see Field 7C.
W90-02642

DIURNAL VARIATION OF PRECIPITATION IN CALIFORNIA AND NEVADA.
State Univ. of New York at Albany. Dept. of Atmospheric Science.
M. G. Landin, and L. F. Bosart.
Monthly Weather Review MWREAB, Vol. 117, No. 8, p 1801-1816, August 1989. 10 fig, 15 ref.

Descriptors: *Meteorology, *Climatology, *California, *Nevada, *Precipitation, *Rainfall, *Seasonal variation, *Rainfall distribution, Weather, Climates, Statistical methods.

The diurnal variation of precipitation across California and Nevada has been studied by means of a harmonic analysis of 35 years of hourly precipitation data for 347 stations, and a regional probability of precipitation analysis for grouped stations. Results are shown for the cool (November-April) and warm (May-October) seasons. For all measurable (> 0.25 mm) precipitation events, the phase of the cool season diurnal cycle tends to peak between 0300-0900 LST along the coast, between 1000-1300 LST in the coastal mountains and the Sierra Nevada and in the Sacramento and San Joaquin valleys, and between 0800-1200 LST in most of Nevada. For the heavier (> 2.5 mm) precipitation events, the phase of the cool season diurnal cycle tends to peak from 1300-1800 LST at many locations. Exceptions include the eastern Sierra Nevada and Nevada, where a maximum near 1000 LST is found and along the coast and coastal mountains where a predawn maximum occurs. The transition from a late morning precipitation maximum along the coast and in the Sacramento Valley to an early evening maximum in the San Joaquin Valley is well defined in the gap in the coastal mountains through the San Francisco Bay area. During the warm season, precipitation tends to maximize between 1400-2200 LST at most interior locations and in portions of the coastal mountains in phase with the diurnal heating cycle. Coastal areas from Santa Barbara to San Diego retain a 0300-0700 LST precipitation maximum for the lighter precipitation amounts, characteristic of the well-known coastal summer stratus regime. (Author's abstract)
W90-02644

RATIOS OF DRY TO WET DEPOSITION OF SULFUR AS DERIVED FROM PRELIMINARY FIELD DATA.

National Oceanic and Atmospheric Administration, Oak Ridge, TN. Atmospheric Turbulence and Diffusion Div.
For primary bibliographic entry see Field 5B.
W90-02662

ANTICIPATING THE FREQUENCY DISTRIBUTION OF PRECIPITATION IF CLIMATE CHANGE ALTERS ITS MEAN.
Connecticut Agricultural Experiment Station, New Haven. Dept. of Horticulture and Forestry.
P. E. Waggoner.
Agricultural and Forest Meteorology AFMEEB, Vol. 47, No. 2-4, p 321-337, Sep 1989. 11 fig, 2 tab, 9 ref.

Descriptors: *Climatology, *Global warming, *Climates, *Precipitation, Frequency distribution, Mathematical analysis, Statistical analysis, Climatic change.

The relationship between the shape and dispersion of the frequency distributions of precipitation amounts and their means among present climates gives a clue as to how the probabilities of extremes will change if the mean changes. The distribution is limited at zero and, as the means decrease, the standard deviations decrease and the distributions become more skewed. The gamma distribution function fits these distributions from the nearly normal of annual amounts in humid climates to the skewed of monthly amounts in arid ones. Its mean, M, is BG and variance, V, is B sq G, where B is the scale and G the shape parameter. Among 660 cases of 12 monthly distributions at 55 diverse stations, the variance increased as M to the 1.3 power (r sq =0.90), which specifies relationships between the mean and B and G. Thus, probabilities are specified by the mean and among 660 cases, 572 specified probabilities of amounts less than half the mean were not significantly different from observed. For precipitation more than three halves the mean, 653 were not significantly different from observed. The relationships among parameters specify a dimensionless elasticity or relative increase in the probability of extremes with a relative decrease in the mean. For amounts below a threshold, the elasticity is greater for lower thresholds and higher means, and it is often > 1, signifying a relatively greater rise in the probability of extremes than a fall in the mean. (Author's abstract)
W90-02782

PHYSICAL MODEL TO COMPLEMENT RAINFALL NORMALS OVER COMPLEX TERRAIN.
Tel-Aviv Univ. (Israel). Raymond and Beverly Sackler Faculty of Exact Sciences.
P. Alpert, and H. Shafir.
Journal of Hydrology JHYDA7, Vol. 110, No. 1/2, p 51-62, Sep 1989. 8 fig, 1 tab, 16 ref. Bi-National U.S.-Israel Science Foundation Grant No.8600320.

Descriptors: *Meteorology, *Climatology, *Model studies, *Precipitation, *Rainfall distribution, *Israel, *Rain gages, Model studies, Radar, Remote sensing, Complex terrain, Data acquisition.

A physical model for high-resolution (delta chi = 1-2 km) rainfall over complex terrain that was recently verified against radar-derived observations is shown to be capable of complementing rainfall normals in Israel. Two examples illustrate that even high resolution rain-gage networks may miss important small-scale rainfall features over highly complex terrain, which are effectively detected by a simplified linear and adiabatic model. Through annual averages the physical model detects high-resolution features of the rainfall distribution which do not exist in the observational maps. The model could be effectively used in conjunction with statistical models to complement rainfall averages in data-free regions. In addition, the model output can serve as an initial guide for regions of high and low gradients of precipitation when planning rain-gage networks. (Author's abstract)
W90-02798

Group 2B—Precipitation

CHANGES IN THE COMPOSITION OF RAIN-WATER UPON PASSAGE THROUGH THE CANOPIES OF TREES AND OF GROUND VEGETATION IN A DUTCH OAK-BIRCH FOREST.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Geology.
For primary bibliographic entry see Field 5B.
W90-02826

RAINFALL-RUNOFF TRANSFER FUNCTION BY ARMA MODELING.
Marquette Univ., Milwaukee, WI. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03223

ESTIMATING PROBABILITIES OF EXTREME RAINFALLS.
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.
T. A. Fontaine, and K. W. Potter.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 11, p 1562-1575, November 1989. 4 fig, 3 tab, 11 ref, append.

Descriptors: *Rainfall, *Rainstorms, *Design flow, *Flood forecasting, *Weather forecasting, *Model studies, *Rainfall-runoff relationships, *Probable maximum flood, Stochastic storm transposition, Probable maximum precipitation, Floods.

For a variety of design purposes there is increasing interest in estimating probabilities of rare floods, with magnitudes up to the probable maximum flood. One estimation approach, which is termed 'stochastic storm transposition,' is a generalization of the concept of storm transposition, which is the basis for estimating probable maximum precipitation. Two alternative formulations of the stochastic storm transposition concept are applied to a catchment in the midwestern U.S. It is clear from these applications that before the concept can be applied routinely its theoretical basis must be strengthened and several potentially large sources of uncertainty must be explored. (Author's abstract)
W90-03399

SALIENT FEATURES OF THE RAIN SPELLS AT COCHIN.
Cochin Univ. of Science and Technology (India). School of Marine Sciences.
C. K. Rajan.
Bulletin of the Department of Marine Sciences University of Cochin, Vol. 14, p 131-140, 1986-88. 3 fig, 3 tab, 6 ref.

Descriptors: *Monsoons, *Cochin, *India, *Rainfall intensity, Diurnal distribution.

The nature of the rain spells at Cochin during the pre-, southwest and retreating monsoon seasons and the rainfall data for a ten year period 1973-1982 have been examined without splitting them according to the chronological hours. During the southwest monsoon season, most rain spells begin during the early morning hours and the fewest occur during the noon hours. In the pre and retreating monsoon seasons the corresponding maxima and minima are during the evening hours and the forenoon/noon hours respectively. Of the approximately 360 spells received during the southwest monsoon season, 250 continued for less than 30 minutes, approximately 70 exceed 1 hour, and 8 exceeded 5 hours; only 1 spell lasted longer than 10 hours. During the pre monsoon season there were 50 spells, of which 30 ceased after 30 minutes and 12 continued for more than 1 hour. During the retreating monsoon season, there were 70 spells, of which 40 ceased within 30 minutes and 16 continued for more than 1 hour. No spells exceeded 10 hours during either of these seasons. During the southwest monsoon season, 135 (38%) spells had a rainfall of 1 mm or less; 311 (87%) had an amount of 1 com or less, while only one spell exceeded 10 cm. During the pre monsoon season the corresponding figures were 16 (31%) for 1 mm or less, and 42 (81%) for 1 cm or less and for the retreating monsoon season 23 (33%) 1 mm or less and 55 (79%) respectively. (Author's abstract)

W90-03456

SOME EFFECTS OF THE CYCLONES DO-MOINA AND IMBOA ON MANGROVE COM-MUNITIES IN THE ST LUCIA ESTUARY.
Durban-Westville Univ. (South Africa). Dept. of Botany.
T. D. Steinke, and C. J. Ward.
South African Journal of Botany SAJBDD, Vol. 55, No. 3, p 340-348, June 1989. 6 fig, 6 tab, 6 ref.

Descriptors: *Cyclones, *Flooding, *South Africa, *Estuaries, St Lucia Estuary, Algae, Mangrove swamps.

The cyclones Domoina and Imboa struck the St. Lucia area in January/February 1984. Research in progress at the time made it possible to assess some of the effects of these cyclones on the mangrove communities of the St. Lucia Estuary. Assessment has been based on aerial and ground observations, litter studies in an Avicennia marina (Forssk.) Vierh. and a Bruguiera gymnorrhiza (L.) Lam. stand, mortality counts in the above B. gymnorrhiza stand and biomass determinations of algae epiphytic on A. marina pneumatophores. The heavy rainfall which accompanied the cyclones, and the subsequent flooding of the rivers, caused lake levels to rise and the floodwaters inflicted damage on mangrove stands. Destruction of the A. marina stand in which litter collections were being made, terminated this study. However, continued recordings were possible of leaf and stem litter and reproductive material to be made. Die-back of branches and trees resulted in a significant increase in leaf litter for up to 8 months following the cyclones. Propagules and flowering material were lost in the floodwaters, the loss of the latter material causing minimal propagule production in the fruiting season after the cyclones. Total counts of trees and saplings 1 m and over revealed that B. gymnorrhiza suffered the greatest mortality with 67.1% living and 32.9% dead, whereas a. marina had 83.% living and 16.2 dead. However, of all woody plants in this stand B. gymnorrhiza comprised 92% and A. marina 5.5%. Low biomass values of epiphytic algae were recorded as a result of the floodwaters, but recovery was rapid and very high yields were recorded the following warm season. The species composition of this algal community was not altered by the events. The immediate effects of the cyclones comprised damage to the standing crop by the direct impact of the floodwaters and also a loss of plant litter. Long-term effects included a reduction in propagative material and stress, resulting in leaf loss and death, mainly of B. hymnorrhiza. (Author's abstract)
W90-03474

2C. Snow, Ice, and Frost

WATER YIELD FROM FOREST SNOWPACK MANAGEMENT: RESEARCH FINDINGS IN ARIZONA AND NEW MEXICO.
Arizona Univ., Tucson. School of Renewable Natural Resources.
For primary bibliographic entry see Field 4A.
W90-02588

NUMERICAL STUDY OF THE EAST COAST SNOWSTORM OF 10-12 FEBRUARY 1983.
Naval Research Lab., Washington, DC.
For primary bibliographic entry see Field 7C.
W90-02643

FINITE-ELEMENT ANALYSIS OF THE TRANSPORT OF WATER, HEAT AND SO-LUTES IN FROZEN SATURATED-UNSATU-RATED SOILS WITH SELF-IMPOSED BOUNDARY CONDITIONS.
Quebec Univ., Sainte-Foy.
F. Padilla, J. P. Villeneuve, and M. Leclerc.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cam-bridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 121-126, 4 fig, 12 ref.

Descriptors: *Saturated flow, *Unsaturated flow, *Galerkin method, *Finite element method, *Model studies, *Frozen ground, *Boundary conditions, *Soil water, *Solute transport, *Heat flow, Mathematical studies, Differential equations, Stefan problem, Finite element method, Errors, Velocity.

The finite-element method based on a Galerkin technique was used to simulate the one-dimensional transient movement of water, heat, and solutes in saturated and partially saturated frozen porous media. Differential equations and physical laws were used to solve simultaneously water pressure, temperature, and water chemistry. These unknowns are coupled with phase changes, frost heave, and other parameters through several solutions to the discontinuity concept of the Stefan problem. When phase changes occur at the surface of the soil, special boundary conditions need to be considered. The model also uses self-imposed boundary conditions that depend on the solution and are useful for outflow boundaries. Several temporal schemes are available to solve nonlinearities, depending on the precision desired and the execution time. The time steps are defined with respect to the diffusion parameter as well as the Courant and Peclet numbers of each equation to guarantee stable solutions. However, high gradients in water velocity give occasional monotonic error growth for very small time steps. (See also W90-02980) (Author's abstract)
W90-02997

VARIABLY SATURATED FINITE-ELEMENT MODEL FOR HILLSLOPE INVESTIGATIONS.
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
For primary bibliographic entry see Field 2E.
W90-02998

THIN ICE: RADAR IDENTIFICATION OF THIN AND NOT SO THIN LAYERS IN HY-DROLOGICAL MEDIA.
Cold Regions Research and Engineering Lab., Hanover, NH.
K. O'Neill.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cam-bridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 371-377, 7 fig, 4 ref.

Descriptors: *Hydrology, *Ice, *Remote sensing, *Radar, Data processing, Ice thickness, Satellite technology, Performance evaluation, Data acquisition.

Many remote sensing systems have been tried or proposed for identifying interfaces in surface and subsurface media. As an example, the use of short pulse radar applied to ice layers is considered here. A computational system is required that will mark clearly reflections from interfaces while suppressing other unwanted response as much as possible, so that automated layer detection is possible. For sufficiently thick, non-dissipative hydrological layers, well-separated impulse radar reflections may be obtained that correspond to returns from interfaces and their multiples. By suitably modifying a straightforward, band-limited inverse filter, these returns can be distinguished in field records and the thickness of the ice, and presumably other layers, can be estimated successfully. For thin layers, which produce overlapping interface returns, successful thickness estimations by referring to a set of synthetic total reflections including all multiples. The synthetic signals correspond to various possible thicknesses, and the best correlation between measured and synthetic reflections points to the correct thickness. (See also W90-02980) (Rochester-PTT)
W90-03033

SATELLITE OBSERVATIONS OF OCEANS AND ICE.
Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 7B.
W90-03034

DOWNSLOPE MOVEMENT OF CHLORSULFURON AFTER CONVENTIONAL AND OVER-SNOW APPLICATIONS TO WINTER WHEAT.
Utah State Univ., Logan. Dept. of Plant Science.
For primary bibliographic entry see Field 5B.
W90-03417

2D. Evaporation and Transpiration

MODEL OF TRANSPIRATION AND SOIL-WATER BALANCE FOR A MATURE OAK FOREST.
Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Paris (France).
J. Nizinski, and B. Saugier.
Agricultural and Forest Meteorology AFMEEB, Vol. 47, No. 1, p 1-17, Jul 1989. 6 fig, 38 ref.

Descriptors: *Transpiration, *Soil-water-plant relationships, *Forest hydrology, Oak trees, Throughfall, Model studies, Stomatal transpiration, France.

A hydrological model for the development of the soil-water content in a 120-year-old oak stand (Quercus petraea) with a 1-day time resolution is presented. The model was developed for working with daily potential evapotranspiration, throughfall and leaf area index data. It predicts transpiration from the dry canopy and soil-water content. The canopy is considered as a single leaf (the Penman-Monteith equation) which entails measurements of the physiological control of vapor flow from the leaf such as stomatal resistance (porometer), leaf water potential (pressure chamber), leaf area index, root distribution and soil-water potential (tensiometers). The model estimates the daily leaf water potential that controls the opening of the stomata which in turn regulate the transpiration flow by equating soil moisture abstraction and transpiration. The model was tested using data for the growing seasons of the Fontainebleu forest near Paris (France) in 1981, 1982 and 1983. Simulated transpiration and soil-water content correlated well with neutron probe measurements of the soil-water content. The model can be used for the quantification of tree water stress, which has numerous applications such as assessing stand productivity, disease and insect epidemic susceptibility, fire danger rating and nutrient cycling. (Author's abstract)
W90-02779

EVAPOTRANSPIRATION IN A GREENHOUSE-WARMED WORLD: A REVIEW AND A SIMULATION.
Resources for the Future, Inc., Washington, DC. Climate Resources Program.
N. J. Rosenberg, M. S. McKenney, and P. Martin.
Agricultural and Forest Meteorology AFMEEB, Vol. 47, No. 2-4, p 303-320, Sep 1989. 2 fig, 2 tab, 42 ref, append.

Descriptors: *Greenhouse effect, *Evapotranspiration, *Global warming, *Climatology, Model studies, Simulation analysis, Plant growth, Stomatal transpiration.

The ways in which the greenhouse effect may affect evapotranspiration (ET) rates are briefly reviewed. ET may change because of atmospheric warming and because of associated changes in other climatic factors. ET rates may also be altered by the stimulation of plant growth and increase in stomatal resistance that occur in response to CO_2 enrichment of the atmosphere. The Penman-Monteith model of evapotranspiration was employed with data from four different ecosystems to estimate the possible range of changes in ET which may occur in response to the climatic and plant changes mentioned above. The climatic and plant factors were first varied individually to determine model sensitivity. These factors were then varied

simultaneously according to scenarios of climatic change to determine their combined impact on ET. Depending on the ecosystem and on climatic conditions, ET can differ by -20 to +40% from the control case (no climate or plant change). These analyses illustrate the danger of assuming that global warming will increase ET in all circumstances. (Author's abstract)
W90-02781

ESTIMATION OF SENSIBLE HEAT FLUX FROM MEASUREMENTS OF SURFACE RADIATIVE TEMPERATURE AND AIR TEMPERATURE AT TWO METERS: APPLICATION TO DETERMINE ACTUAL EVAPORATION RATE.
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Water Resources.
J. P. Brunel.
Agricultural and Forest Meteorology AFMEEB, Vol. 46, No. 3, p 179-191, May 1989. 4 fig, 1 tab, 23 ref.

Descriptors: *Instrumentation, *Evaporation rate, *Heat transfer, Surface temperature, Mathematical analysis, Surface roughness, Radiation, Wind, Air temperature.

From measurements of sensible heat flux (H), using the simplified aerodynamic approach, and measurements of surface thermal infrared temperature (Ts), both in arid and semi-arid areas of Tunisia, it is shown that a simple linear relationship can be used to estimate H from the difference (Ts--Ta), Ta being the air temperature at 2 m. It is also pointed out that this relationship can be used in unstable conditions for various types of surface roughness. Application to determine actual evaporation rate is made using the similarity of the H/net radiation (Rn) instantaneous values at noon with the average daily values of H/Rn. It was concluded that over a fairly large range of wind speed conditions, provided they are in unstable conditions, the heat flux H can be estimated quite satisfactorily with measurement of just radiative surface temperature and air temperature. (Author's abstract)
W90-02794

ENERGY BALANCE DETERMINATIONS CLOSE TO THE SOIL SURFACE USING A MICRO-BOWEN RATIO SYSTEM.
California Univ., Davis. Dept. of Land, Air and Water Resources.
H. Ashktorab, W. O. Pruitt, K. T. Paw U, and W. V. George.
Agricultural and Forest Meteorology AFMEEB, Vol. 46, No. 3, p 259-274, May 1989. 6 fig, 1 tab, 34 ref.

Descriptors: *Instrumentation, *Evaporation, *Lysimeters, *Energy, Soil, Micro-Bowen ratio system, Temperature, Humidity, Latent heat, Hygrometry.

A micro-Bowen ratio system, with beta (ratio of sensible to latent heat flux) determined from temperature and humidity measurements very close to the soil surface (1 and 6 cm), was tested above bare soil by comparison with evaporation losses from a highly sensitive 6.1-m diameter lysimeter. The results indicated good accuracy in estimation of evaporation (E) during 8 days with moist soil-surface conditions, as well as 1 day of second-stage drying conditions when E averaged only 30-40% of a calculated reference crop evapotranspiration. Good agreement between estimated and measured E was also found, using a Bowen ratio system with a chilled mirror hygrometer sensing air sampled at 5 and 85 cm above the soil surface. On one of the study days a second Bowen ratio system (psychrometric with sensors at 5 and 85 cm) was employed as well as eddy-correlation instrumentation for measuring sensible heat flux (H), with H used in the energy balance equation to solve for LE (where L is the latent heat of vaporization for water). Close agreement with lysimeter-determined E and calculated E from these two systems was noted although in later afternoon hours some divergence occurred, probably produced as upwind soil surfaces developed inhomogeneous surface-moisture conditions. The results suggest

that the microsystem approach should be applicable to under-canopy and small-plot studies where traditional methods are impractical. (Author's abstract)
W90-02795

OPERATIONAL ESTIMATES OF REFERENCE EVAPOTRANSPIRATION.
Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering.
R. G. Allen, M. E. Jensen, J. L. Wright, and R. D. Burman.
Agronomy Journal AGJOAT, Vol. 81, No. 4, p 650-662, Jul/Aug 1989. 8 fig, 11 tab, 55 ref, append.

Descriptors: *Evapotranspiration, *Canopy, *Alfalfa, *Grasses, *Penman equation, Lysimeters, Penman-Monteith method, Climates, Canopy, Mathematical equations.

Many forms of the Penman combination equation have been proffered for estimating daily evapotranspiration by the agricultural reference crops grass and alfalfa (Medicago sative L.). This study was conducted to evaluate popular forms of the Penman equation, and to develop and evaluate general relationships for estimating daily average values of canopy and aerodynamic resistance parameters required by the Penman-Monteith equation. For simplicity and ease of use, resistance relationships were expressed as linear and logarithmic functions of mean plant height. The Penman-Monteith and other forms of the Penman equation were compared at 11 international lysimeter sites, with the Penman-Monteith method and a Penman equation with variable wind function developed at Kimberly, ID providing the best estimates of reference evapotranspiration across the sites. Ratios of computed alfalfa to grass reference evapotranspiration during peak months at various locations averaged 1.32, and ranged from 1.12 to 1.43. Values of computed ratios were related to local wind and humidity conditions. The development of relationships for canopy and aerodynamic resistances as functions of reference crop height allowed use of the Penman-Monteith equation in an operational mode, and improved transferability of this resistance form of the Penman equation to a wide variety of climates. (Author's abstract)
W90-03278

FRACTION OF THERMAL UNITS AS THE BASE FOR AN EVAPOTRANSPIRATION CROP COEFFICIENT CURVE FOR CORN.
Saint Rose School, Belmar, NJ.
B. Amos, L. R. Stone, and L. D. Bark.
Agronomy Journal AGJOAT, Vol. 81, No. 5, p 713-717, Sep/Oct 1989. 2 fig, 2 tab, 24 ref.

Descriptors: *Crop yield, *Soil-water-plant relationships, *Temperature effects, *Evapotranspiration, *Corn, *Mathematical studies, Coefficient curves, Plant physiology, Regression analysis.

A need exists to determine if evapotranspiration crop coefficient curves, based on a fraction of thermal units concept, could be used across cultivars that require various thermal unit totals from emergence to physiological maturity. The objective of this study was to develop such a curve for corn and then to test the ability of this curve to estimate evapotranspiration of cultivars of various maturity lengths. A basal crop coefficient curve for corn was developed by using field data obtained from 1974 to 1982 near Manhattan, KS and during 1981 and 1982 near Tribune, KS. The method involved calculating the ratios of measured evapotranspiration rates adjusted for surface evaporation to reference evapotranspiration rates, adjusting these ratios for the amount of available soil water, and then performing regression of the adjusted ratios against fraction of thermal units. The developed basal crop coefficient curve was then used to estimate the evapotranspiration rate of three corn cultivars grown near Manhattan, KS in 1983 and 1984. We then performed linear regression of estimated evapotranspiration against measured evapotranspiration rates (water balance technique) for each cultivar. All regression equations

Group 2D—Evaporation and Transpiration

and coefficients were significant at P is less than 0.001. The hypotheses that intercept equals zero and slope equals 1 could not be rejected for any of the cultivars. The use of fraction of thermal units as the crop coefficient base scale allowed for a general and accurate use of the basal crop coefficient curve across corn cultivars requiring various thermal unit totals from emergence to physiological maturity. (Author's abstract)
W90-03281

TRANSPIRATION EFFICIENCY OF OAT.

Goettingen Univ. (Germany, F.R.). Inst. of Agronomy and Plant Breeding.
W. Ehlers.
Agronomy Journal AGJOAT, Vol. 81, No. 5, p 810-817, Sep/Oct 1989. 6 fig, 8 tab, 28 ref.

Descriptors: *Transpiration, *Soil-water-plant relationships, *Evapotranspiration, *Oats, *Water use efficiency, Silt, Loam, West Germany, Transpiration, Evaporation, Climates, Soil water tension, Leaf area index.

Dry matter production, water use, and their ratio vary among species and with climatic conditions. This study was undertaken to determine the water use efficiency of oat because recent field evaluations for this crop are not available. Oat was grown on loess-derived silt loam near Goettingen, West Germany, during 4 years. Periodically, shoot and root dry matter were determined. Water use within five consecutive growth stages was evaluated by the soil water budget approach. Balanced evapotranspiration, including evaporation from soil, water intercepted by leaves, and transpiration from plants, was divided into its components by calculation procedures. Evaporation was approximated from meteorological factors, leaf area index, and soil water tension, and water intercepted by leaves from daily precipitation and leaf area index. Shoot and total oat dry matter including roots were linearly related to cumulative transpiration from plants, balanced evapotranspiration, and interception plus transpiration. The x-intercept of the regression line was nearest to zero, when x was interception plus transpiration. Therefore, water intercepted by leaves was regarded to be part of productive water use. Including water intercepted by leaves and considering only shoot dry matter, the water use efficiency of interception plus transpiration was 4.1 kg/cubic m. When considering shoots and roots, water use efficiency of interception plus transpiration increased to 4.5 kg/cubic m. The relation between dry matter production and interception plus transpiration was improved by relating interception plus transpiration to the potential evapotranspiration rate or the saturation deficit of the air. As compared with other crops water use efficiency of interception plus transpiration of oat appeared to be lower. This study provided evidence that normalization of interception plus transpiration by the saturation deficit requires the appropriate evaluation of saturation deficit for the daylight period when transpiration occurs. (Author's abstract)
W90-03285

ESTIMATION OF SURFACE WATER EVAPORATION RATES BY CONTINUOUS RADIO-GAUGING.

Macdonald Coll., Ste. Anne de Bellevue (Quebec). Dept. of Renewable Resources.
N. N. Barthakur, and J. S. Tomar.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 18, No. 10, p 1117-1130, Oct 1987. 2 fig, 2 tab, 15 ref.

Descriptors: *Instrumentation, *Evaporimeters, *Evaporation rate, *Leaves, *Measuring instruments, *Radioactivity techniques, *Soil properties, Mathematical models, Beta-rate gages, Estimating, Surface wetness, Fluid drops, Drying, Irrigation, Soybeans, Soil management, Precipitation.

The principal sources of leaf wetness are rain, dew, and sprinkler irrigation which may deposit a water layer or water droplets depending upon the physical nature of the surface. Evaporation of water drops from an otherwise dry leaf surface was found to be significantly different from drying of a uniformly wet surface. Several methods, none too satisfactory, are available to measure the amount of surface water and surface wetness duration. Drying characteristics of thin sections of soil are also important from the viewpoint of seed germination, surface irrigation, wind erosion, and soil and water management practices. Development of a suitable experimental technique is desirable to study evaporation characteristics of very thin layers of soil under various environmental conditions. A beta-ray gage system was used to estimate the water evaporation rates from artificial and soil surfaces. The predictions of a mathematical model based on cylindrical water drops agreed fairly well with the original observations of such water drops on soybean leaves. The drying time of a surface was found to be highly dependent upon whether it was wetted with drops or with a uniform layer. Gravimetrically determined evaporation rates from soil surfaces were highly correlated with those obtained by the beta-ray gauge under various environmental conditions. Field application of the beta-ray gauge in measuring water evaporation rates is suggested on the basis of its performance in the laboratory. (Author's abstract)
W90-03292

EFFECTS OF IRRIGATION REGIMES ON YIELD AND WATER USE OF SUMMER SQUASH.

Georgia Coastal Plain Experiment Station, Tifton.
For primary bibliographic entry see Field 3F.
W90-03362

2E. Streamflow and Runoff

APPROXIMATING RAINFALL-RUNOFF MODELLING UNCERTAINTY USING THE STOCHASTIC INTEGRAL EQUATION METHOD.

Williamson and Schmid, Irvine, CA.
For primary bibliographic entry see Field 2A.
W90-02547

MODELING OF TWO-DIMENSIONAL OVERLAND FLOW.

Washington Univ., Seattle. Dept. of Civil Engineering.
W. Zhang, and T. W. Cundy.
Water Resources Research WRERAQ, Vol. 25, No. 9, p 2019-2035, September 1989. 19 fig, 28 ref. USGS Grant No. 14-08-0001-G1154 and NSF Grant EAR85-18058.

Descriptors: *Rainfall-runoff relationships, *Model studies, *Geomorphology, *Topography, *Overland flow, *Terrain analysis, *Soil erosion, Path of pollutants, Slopes, Surface runoff, Infiltration, Spatial distribution, Hydraulic properties, Hydrographs, Hydrodynamics, Numerical analysis, Flow characteristics, Flow velocity.

Natural hillslopes on which overland flow is generated are seldom planar surfaces with homogeneous physical and hydraulic properties. Microtopography, surface roughness, and soil hydraulic properties vary over distances of centimeters to meters, and they strongly influence runoff characteristics along the hillslope, and hillslope hydrographs. These spatial variations have significant impacts on soil erosion and contaminant transport. A two-dimensional hydrodynamic and numerical model for overland flow has been developed which allows spatial variations in hillslope physical characteristics, including surface roughness, infiltration, and microtopography. The accuracy of the model is tested by comparison with characteristic-based solutions and experimental data. The results of these tests indicate that the model to two-dimensional overland flow on hillslopes is demonstrated by applying it to surfaces with spatially variable roughness, infiltration, and microtopography. These simulations show that microtopography is the dominant factor causing spatial variation in overland flow depth, velocity, and direction. (Author's abstract)
W90-02590

SCALING AND ELEVATION IN RIVER NETWORKS.

Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
D. G. Tarboton, R. L. Bras, and I. Rodriguez-Iturbe.
Water Resources Research WRERAQ, Vol. 25, No. 9, p 2037-2051, September 1989. 10 fig, 2 tab, 34 ref.

Descriptors: *Geomorphology, *Erosion, *Channel morphology, *River systems, *Elevation, *Stream erosion, *Slope degradation, *Hypsometric analysis, *Channel erosion, Standard deviation, Slopes, Model studies.

A necessary step in understanding the link between erosive energy balance and network form is the description of the variation of slopes and elevation drops within a river network. Investigators have recently suggested that channel slopes are self-similar with magnitude or area as a scaling parameter. However, certain data indicates otherwise; in particular, the variance of channel slope is larger than that predicted by simple self-similarity. This suggests multiscaling. The scaling exponent for the standard deviation is approximately half the corresponding exponent in the relationship of the slope mean to magnitude or area. A model for channel slopes based on a point process of elevation drops along the channel has been developed. The model reproduces observed multiscaling properties when the density of elevation increments is specifically related to the area (or magnitude). (Author's abstract)
W90-02591

PARAMETRIC MODEL FOR STEEPLY SLOPING FORESTED WATERSHEDS.

Kentucky Univ., Lexington. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W90-02592

APPLICATIONS OF INTERVENTION ANALYSIS TO MODEL THE IMPACT OF DROUGHT AND BUSHFIRES ON WATER QUALITY.

Rural Water Commission of Victoria, Armadale (Australia). Water Quality Assessment Section.
For primary bibliographic entry see Field 7C.
W90-02649

HYDROLOGICAL REGIONALIZATION OF STREAMS IN VICTORIA, AUSTRALIA, WITH IMPLICATIONS FOR STREAM ECOLOGY.

Melbourne Univ., Parkville (Australia). Dept. of Geography.
J. M. R. Hughes, and B. James.
Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 40, No. 3, p 303-326, 1989. 11 fig, 4 tab, 80 ref.

Descriptors: *Stream gages, *Streamflow, *Regional analysis, Streamflow data, Australia, Runoff, Rivers, Arid lands, Least squares method, Statistical analysis.

Annual, monthly, low and peak flow data were used to classify and ordinate 138 stream gages in Victoria. Sixteen hydrological variables were used and low-flow and entire-flow regionalizations were derived. The low-flow regionalization produced five distinctive and spatially significant regions. Least-squares relationships were calculated between mean annual runoff, catchment area and coefficient of variation of annual flows, and the 16 variables. Rivers in the dry western districts of Victoria exhibit high variability of annual, monthly and peak flows, and two specific low flows. The converse is true for rivers in the western highlands of Victoria. Stream regionalizations are a useful tool for stream ecologists, and may be used for generating hypotheses, for detecting representative rivers and for producing baseline stream surveys. (Author's abstract)
W90-02651

WATER BUDGET MODEL FOR THE TROPICAL MAGELA FLOOD PLAIN.
Office of the Supervising Scientist for the Alligator Rivers Region, Sydney (Australia).
For primary bibliographic entry see Field 5B.
W90-02658

EFFECTS OF STATIC VERSUS FLOWING WATER ON AQUATIC PLANT PREFERENCES OF TRIPLOID GRASS CARP.
Agricultural Research Service, Davis, CA. Aquatic Weed Control Research Lab.
For primary bibliographic entry see Field 2H.
W90-02691

DISTRIBUTION OF WATER DISCHARGES AND CURRENT VELOCITIES IN A BRAIDED CHANNEL.
For primary bibliographic entry see Field 2J.
W90-02696

FORMATION OF SAND RIDGES IN CANALS.
For primary bibliographic entry see Field 2J.
W90-02697

VARIABILITY IN PHOTOSYNTHESIS: IMPACT ON DO MODELS.
Michigan Technological Univ., Houghton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W90-02719

MEASUREMENT OF REAERATION IN STREAMS: COMPARISON OF TECHNIQUES.
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W90-02722

IMPORTANCE OF PHYSICAL VARIABLES ON THE SEASONAL DYNAMICS OF EPILITHIC ALGAE IN A HIGHLY SHADED CANYON STREAM.
Northern Arizona Univ., Flagstaff. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-02727

SUSPENDED SEDIMENTS AND THE DISTRIBUTION OF BOTTOM SEDIMENTS IN THE NIAGARA RIVER.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 2J.
W90-02749

PHYSICALLY BASED DISTRIBUTION FUNCTION FOR LOW FLOW.
Oslo Univ. (Norway). Inst. of Geophysics.
L. Gottschalk, and G. Perzyna.
Hydrological Sciences Journal HSJODN, Vol. 34, No. 5, p 559-573, Oct 1989. 6 fig, 2 tab, 19 ref.

Descriptors: *Surface-groundwater relations, *Norway, *River flow, *Hydrographs, *Low flow, Model studies, Precipitation, Groundwater, Surface flow, Watersheds.

For Norwegian conditions, river low flow is controlled by groundwater discharge and outflow from lakes. To derive a physically based distribution function of low flow, a natural point of departure has therefore been a traditional baseflow equation, describing the true recession part of the hydrograph. The most important variable to determine the low flow is the maximal length of periods without rain during a low flow season (here summer). This latter stochastic variable can be expected to have a homogeneous and stable distribution over large areas. By analyzing several hydrographs for each catchment by the sliding method, sets of parameters were derived. Two modifications were made when testing the model: (1) the maximal 'dry weather period' during the summer was defined as a continuous period of days

with precipitation amount under some threshold value; and (2) an introduced modification to reflect the fact that the low flow values belong to two different populations, one for dry summers when groundwater recession is observed, and the other one for wet summers. When the data is censored in this manner, a good fit is achieved between model and observed data. Local information from a certain river was successfully utilized in terms of the parameters of a recession equation in the derived distribution function. However, complementary studies of the stability and distribution of certain parameters are needed. (White-Reimer-PTT)
W90-02762

CHARACTERIZATION OF TOXIGENIC VIBRIOS ISOLATED FROM THE FRESHWATER ENVIRONMENT OF HIROSHIMA, JAPAN.
Hiroshima Univ. (Japan). Dept. of Food Microbiology and Hygiene.
For primary bibliographic entry see Field 5A.
W90-02789

FLOOD FORECASTING BY THE FILTER SEPARATION AR METHOD AND COMPARISON WITH MODELING EFFICIENCIES BY SOME RAINFALL-RUNOFF MODELS.
Utsunomiya Univ. (Japan). Dept. of Civil Engineering.
M. Hasebe, M. Hino, and K. Hoshi.
Journal of Hydrology JHYDA7, Vol. 110, No. 1/2, p 107-136, Sep 1989. 19 fig, 3 tab, 12 ref.

Descriptors: *Rainfall-runoff relationships, *Flood forecasting, *Model studies, Filter separation method, Statistics, Rainfall, Simulation analysis, Storage function method.

A flood forecasting system with and without rainfall data, applying the filter separation AR method is proposed. The runoff time series were separated sequentially into two runoff components. Since each hydrologic subsystem was expressible by linear input-output relationships, the rainfall components were inversely estimated from the ARX model or from the response function type model. Future runoff was computed by the ARX or the response function type model utilizing the inversely estimated effective past rainfalls and the extrapolated future rainfalls as input, and, as for the shorter-period runoff, also using the past rainfall data. Secondly, modeling efficiencies for four rainfall-runoff models were calculated and compared. The four models were (1) the filter separation AR model, (2) and (3) two kinds of the generalized storage function model (Prasad model and Hoshi model) to which Karman filtering theory was applied, and (4) the tank model. The generalized storage function method contains the nonlinearity in the runoff equation itself and the single component nonlinear model. The filter separation AR method is composed of linear subsystems, and the nonlinearity of the total system is explained by the nonlinearity of the rainfall separation process into subsystems and the multicomponent model. (Author's abstract)
W90-02801

DERIVING THE UNIT HYDROGRAPH BY ROOT SELECTION.
College of Technology, Dublin (Ireland).
J. E. Turner, J. C. I. Dooge, and T. Bree.
Journal of Hydrology JHYDA7, Vol. 110, No. 1/2, p 137-152, Sep 1989. 14 fig, 5 tab, 8 ref.

Descriptors: *Rainfall-runoff relationships, *Unit hydrographs, *Hydrographs, *Flood hydrographs, *Storm runoff, Model studies, Mathematical analysis, Flood peak, Conceptual models.

De Laine's method of deriving the unit hydrograph from the common roots of polynomials corresponding to different storms is used as a basis for proposing a new procedure in which the unit hydrograph roots can be selected from among the polynomial roots for the runoff of a single storm. The selection is made on the basis that the complex unit hydrograph roots form a characteristic 'skew circle' pattern when plotted on an Argand diagram. A single peaked flood hydrograph from the

River Nenagh and a double-peaked flood from the Owenbeg in Ireland were used as examples. On the basis of these examples, it appears that the unit hydrograph is largely, or entirely, made up of the roots on the 'skew circle'. This observation is consistent with the results for the two conceptual models presented. When dealing with the 'skew circle', the inclusion or exclusion of individual pairs of roots does not substantially alter the overall shape of the unit hydrograph. Application of the procedure to other storms produces similar results. (White-Reimer-PTT)
W90-02802

DISCRETIZATION AND COST-EFFECTIVENESS OF A FINITE ELEMENT SOLUTION FOR HILLSLOPE SUBSURFACE FLOW.
Institute of Hydrology, Wallingford (England).
A. Calver, and W. L. Wood.
Journal of Hydrology JHYDA7, Vol. 110, No. 1/2, p 165-179, Sep 1989. 6 fig, 1 tab, 7 ref.

Descriptors: *Model studies, *Finite element method, *Rainfall-runoff relationships, *Storm runoff, Storm seepage, Time, Simulation analysis, Hydrographs, Grid size, Slopes.

An investigation is carried out into the effects of the size of time and space steps on the discharge and hydraulic potential predictions of a finite element rainfall-runoff model, the Institute of Hydrology Distributed Model version 4. Given the type of rainfall-runoff model methodology and the nature of the subsurface stormflow response considered, certain guidelines can be given for good hydrological prediction and cost-effective modelling. With regard to the overall prediction of hydraulic potential values over the hillslope and the reduction of oscillation in the solution, generally smaller elements are favored with a ratio of horizontal to vertical element dimension of < or = 20 for regular grids, ideally < or = to 10. It is also wise to have generally smaller elements with regard to hillslope discharge prediction over the course of the hydrograph. Finer grids also have the advantage of reducing the necessary run-in time at the beginning of simulation. With this methodology neither number of iterations required nor cumulative mass balance serve as a distinguishing factor for choice between different calculation meshes. The results suggest that with the recommended mesh size, a higher number of nodes should be used if the emphasis is on more accurate prediction and a lower number of nodes if shorter execution time is the priority. (White-Reimer-PTT)
W90-02804

CONSERVING RIVERS IN SOUTHERN AFRICA.
Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
J. H. O'Keeffe.
Biological Conservation BICOBK, Vol. 49, No. 4, p 255-274, 1989. 6 fig, 1 tab, 46 ref.

Descriptors: *Africa, *Water pollution control, *Water pollution prevention, *South Africa, *Rivers, *Conservation, *Environmental protection, Ecology, Management planning, Degradation.

The progress of research on river ecology in southern Africa is reviewed, and it is concluded: (a) that rivers have to be viewed from a holistic conservation perspective, as renewable resources to be exploited within sustainable limits for multiple uses; (b) that they are generally geologically younger, seasonally less predictable, and subject to more violent floods and droughts, than many of the better studied rivers of the northern hemisphere; (c) that taxonomic, distributional and descriptive research has provided considerable ecological information, but that process-oriented studies are still at an early stage; (d) that conservation aims must be viewed within the context of different priority uses for rivers; (e) that rivers are resilient to instream perturbations, but will not recover from structural damage such as bank erosion; (f) that growing population problems are the

root cause of river degradation and will become more serious for the foreseeable future. Four rivers in the south-eastern part of the region, the Great Fish (sixth order), the Buffalo (fourth order), the Yellowwoods (third order) and the Mbashe (sixth order), are used to illustrate levels of conservation status. Threats include impoundment, water abstraction, catchment degradation, water abstraction, pollution and introduced species. (Author's abstract)
W90-02809

CORRELATION OF ENVIRONMENTAL VARIABLES WITH PATTERNS OF DISTRIBUTION AND ABUNDANCE OF COMMON AND RARE FRESHWATER MACROINVERTEBRATES.
Commonwealth Scientific and Industrial Research Organization, Lyneham (Australia). Div. of Wildlife and Ecology.
For primary bibliographic entry see Field 2H.
W90-02811

PCB CONGENERS TO MONITOR WITH CAGED JUVENILE FISH IN THE UPPER HUDSON RIVER.
New York State Dept. of Environmental Conservation, Albany.
For primary bibliographic entry see Field 5A.
W90-02842

WATER RESOURCES AND EFFECTS OF POTENTIAL SURFACE COAL MINING ON DISSOLVED SOLIDS IN HANGING WOMAN CREEK BASIN, SOUTHEASTERN MONTANA.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 4C.
W90-02848

SIMULATION OF STREAMFLOW IN SMALL DRAINAGE BASINS IN THE SOUTHERN YAMPA RIVER BASIN, COLORADO.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 2A.
W90-02856

SELECTED HYDROLOGIC DATA FOR FOUNDATION CREEK AND MONUMENT CREEK BASINS, EAST-CENTRAL COLORADO.
Geological Survey, Denver, CO. Water Resources Div.
G. Kuhn, and R. F. Ortiz.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 88-705, August 1989. 106p, 2 fig, 8 tab, 3 ref. Project CO218.

Descriptors: *Colorado, *Path of pollutants, *Dye releases, *Tracers, *Hydrologic data, Water quality, Wastewater discharge, Traveltime.

Selected hydrologic data were collected during 1986, 1987, and 1988 by the U.S. Geological Survey for the Fountain Creek and Monument Creek basins, east-central Colorado. The data were obtained as part of a study to determine the present and projected effects of wastewater discharges on the two creeks. The data, which are available for 129 surface-water sites, include: (1) About 1,100 water quality analyses; (2) about 420 measurements of discharge, (3) characteristics of about 50 dye clouds associated with measurements of traveltime and reaeration, and (4) about 360 measurements of channel geometry. (USGS)
W90-02857

STATISTICAL SUMMARY OF STREAMFLOW DATA FOR INDIANA.
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-02865

ALLUVIAL AQUIFERS ALONG MAJOR RIVERS.
Texas Univ. at Austin. Dept. of Geological Sciences.
J. M. Sharp.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 273-282. 8 fig, 1 tab, 56 ref.

Descriptors: *Surface-groundwater relations, *Geohydrology, *Geohydrologic units, *Flood plains, *Alluvial aquifers, *River systems, Geohydrologic boundaries, Geologic units, Geologic history, Hydrologic properties, Physiographic provinces, Alluvium, Geochemistry, Accretion, Channels, Meander belt, Flood basins, Groundwater level, Bicarbonates, Calcium compounds, Magnesium compounds.

Alluvium associated with major river systems is an immense, yet relatively untapped source of groundwater. Because of their common geological histories and similar hydrogeologic properties, a number of general conclusions can be made about the hydrology of large river flood-plain aquifers, but site-specific characteristics will alter these generalizations. The major rivers are underfit; their valleys are filled with as much as several hundred feet of alluvial sediments, and the rivers are not fully penetrating. Typically, the alluvium can be subdivided into a sand-gravel substratum deposited by vertical accretion, and a more variable topstratum deposited by lateral accretion. The topstratum is further divided into a channel belt, a meander belt, and a flood basin. The substratum is typically a fining-upward sequence. A variety of groundwater response zones are defined, having rapidly fluctuating groundwater levels, long-term stability, slow groundwater response, predominantly downvalley flow, persistent groundwater highs, and pumping-induced lows in the potentiometric surface. Water is generally of good chemical quality and characteristically is a calcium-magnesium-bicarbonate facies. Tributary alluvial aquifers tend to be larger near the confluence with the main stem. Man has altered the alluvial systems; the long-term effects of these alterations are not yet known. (See also W90-02866) (Fish-PTT)
W90-02899

WESTERN ALLUVIAL VALLEYS AND THE HIGH PLAINS.
For primary bibliographic entry see Field 2F.
W90-02900

FLOODS: HYDROLOGICAL, SEDIMENTOLOGICAL AND GEOMORPHOLOGICAL IMPLICATIONS.
John Wiley & Sons, New York. 1989. British Geomorphological Research Group Symposia Series. Edited by Keith Bevan and Paul Carling. 290p.

Descriptors: *Geomorphology, *Sediment transport, *Floods, *Flood frequency, *Flood plains, *Flood recurrence interval, Flood hydrographs, Flooding, Flood data, Flood basins, Floodwater, Flood control, Flood crest, Flood flow, Flood plain management, Conferences.

This volume of papers is from a workshop held at the University of Lancaster as a joint meeting of the British Geomorphological Research Group and the British Hydrological Society. The main aim of the workshop was to bring together scientific researchers with a common interest in the dynamics of fluvial floods and their effects on the landscape. The hydrology, sedimentology and geomorphological implications of floods are discussed, along with storm runoff, flood wave attenuation, and hydrological models for flood computations. Hydraulics, flow-competence evaluations of the hydraulic parameters of floods, and the effects of floods on rivers are also covered. Other workshop topics included in this book are paleofloods, use of soil information, and fluvial geomorphology. Specific examples, such as the Yellow River flash flood in Ireland and information on the Jokulhlaup Glacier, South Iceland, are also presented. (See W90-02964 thru W90-02979) (Mertz-PTT)
W90-02963

HYDROLOGY, SEDIMENTOLOGY AND GEOMORPHOLOGICAL IMPLICATIONS OF FLOODS: AN OVERVIEW.
Freshwater Biological Association, Ambleside (England).
P. Carling, and K. Beven.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 1-9. 33 ref.

Descriptors: *Floods, *Sedimentology, *Geomorphology, Flood frequency, Prediction, Flood forecasting.

The geological sciences have seen a revolution of thought in respect to catastrophic events and the interpretation of stratigraphic sequences. Similarly, in some geomorphological settings, floods may play a vital role in instigating system change in a way that may not be immediately evident in a relatively impoverished terrestrial, as opposed to extensive oceanic, sedimentary record. The study of flood events inevitably involves probabilistic considerations of magnitude and frequency in relation to the effects. In terms of the human and economic impacts of flooding, peak magnitude or stage may be of primary importance, but it is clear that as far as the sedimentological and geomorphological effects of floods are concerned the relationship between magnitude and effect may be much more complex. Assessing the impact of future natural and anthropogenic perturbations to the environment requires predictive models that are physically realistic. The progress along the road to attaining predictive capability in these sciences is inevitably dependent upon the time scales of the responses. There is now over twenty years' experience of using digital computers for short-period hydrological forecasting. Hydrological predictions of flood events are now made routinely for both gaged and ungaged sites, although the uncertainties in those predictions are not often assessed. Some short time scale geomorphological processes have also been successfully modelled. However, applications of predictive models, to other than hypothetical situations, for the longer time scales involved in sedimentology and geomorphology have been relatively rare. (See also W90-02963) (Mertz-PTT)
W90-02964

STORM RUNOFF GENERATION IN SMALL CATCHMENTS IN RELATION TO THE FLOOD RESPONSE OF LARGE BASINS.
Oxford Univ. (England). Dept. of Geography.
T. P. Burt.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 11-35. 9 fig, 2 tab, 92 ref.

Descriptors: *Rainfall-runoff relationships, *Sediment transport, *Storm runoff, *Floods, *Model studies, *Erosion, Soil erosion, Storm seepage, Land use, Overland flow, Rainfall intensity, Climates, Flood hydrographs.

At the basin scale, the major controls of storm runoff generation are climate and soil, with topography important at the subcatchment level. Both the Partial Area and Variable Source Area models must be invoked in order to relate stormflow production to sediment and solute delivery; even in one small basin, both models may well be applicable. If the distributed nature of sediment and solute delivery is to be better understood, several points require further study, including: patterns of soil erosion in relation to the characteristics and extent of variable source areas; linkage of partial areas to the main channel system; and translatory flow mechanisms and the contribution of old soil water to the flood hydrograph. A further unresolved question relates to the linkage between small tributaries and the larger drainage basin, both in terms of flood runoff and the quality of that water. Flood response may well be sensitive to small changes in land use, and the specific location of such changes may also be important. The use of distributed runoff models for studying such linkages is advocated. (See also W90-02963) (Mertz-PTT)
W90-02965

FLOOD WAVE ATTENUATION DUE TO CHANNEL AND FLOODPLAIN STORAGE AND EFFECTS ON FLOOD FREQUENCY.
Northumbrian Water Authority, Gosforth (England).
D. R. Archer.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 37-46. 5 fig, 8 ref.

Descriptors: *Channel storage, *Flood waves, *Flood basins, Flood channels, Flood-control storage, Floods, Flood frequency, Flood damage, Flood stages, Tees River, England, Bankfull stage.

Flood attenuation and the transformation of flood frequency over a common period were investigated over a reach of the River Tees in northeast England. Variations in shape and slope of flood frequency distributions could be accounted for by the characteristics of channel and flood plain storage. Above bankfull, increasing storage on the floodplain and associated delays due to frictional resistance suppress flood growth at the downstream station. However, mean annual flood is virtually unaffected by overbank flow which does not commence until flow exceeds 350 cu m/s. The effects of channel storage are seen below bankfull. As flood peak and volume increase, attenuation decreases and downstream flood growth becomes steeper. The resulting flood frequency has a break of slope at bankfull discharge. It seems likely that transformation in the reach would give the observed form of downstream distribution for a range of upstream distributions. The transformation has important implications for flood estimation at ungaged sites. Floodplain storage and attenuation is a common phenomenon and it is suggested that suppression of flood growth may be similarly widespread. The effect, however, may be obscured in less ideal reaches where there is a larger lateral inflow contribution, and this could cause difficulties in extrapolation to other sites. Classifying basins into homogeneous groups using cluster analysis or interactive search techniques to optimize the grouping efficiency offer the best opportunity for the inclusion of floodplain and channel effects, but this has not yet been done. There are also practical consequences of confinement of flood flows within flood banks through the reach. The effects of reduced attenuation and shorter flood travel time on property at risk downstream of the protected reach need evaluation. (See also W90-02963) (Mertz-PTT)
W90-02966

PHYSICALLY BASED HYDROLOGICAL MODELS FOR FLOOD COMPUTATIONS.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
S. Ambrus, L. Iritz, and A. Szollosi-Nagy.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 47-55. 5 fig, 8 ref.

Descriptors: *Flood forecasting, *Hungary, *Model studies, *Flood control, Floods, Flood-control storage, Flood profiles, Koros River, Flood warning systems, Mathematical models, Hydrologic models.

The decision-making procedure during floods on big rivers is primarily based on hydrological computations. In Hungary, three models operate in the hydrological support system of flood control. Forecasted and observed discharges, flood storage simulation, and computed and observed longitudinal water profiles downstream from the opened emergency flood storage basins are compared. On the basis of this information, the actual state of the watershed can be analyzed and, if it is needed, an alarm signal for flood alert can be given. As an example, these numerical computations are presented for the Koros River in Hungary. (See also W90-02963) (Mertz-PTT)
W90-02967

FLOOD FREQUENCY AND URBAN-INDUCED CHANNEL CHANGE: SOME BRITISH EXAMPLES.
College of St. Paul and St. Mary, Cheltenham

(England). Dept. of Geography and Geology.
C. R. Roberts.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 57-82. 11 fig, 2 tab, 41 ref.

Descriptors: *Urban hydrology, *Urbanization, *Flood flow, *Erosion, *Flood hydrographs, *Urban runoff, *England, Floods, Flood frequency, Flood stages, Flood control, Flood channels, Vegetation effects, Sedimentation.

An explanation of the extent of urban-induced channel enlargement in terms of the major characteristics of the developed area, and the nature of flood frequency relationships in the catchment, can only be a preliminary statement. It ignores completely many other urban-induced effects, including alterations in the timing of flood peaks, hydrograph shapes and their sediment concentrations and particle size characteristics. Urbanization on chalk catchments, for example, may produce double-peaked hydrographs with urban-derived water passing from the catchment before the arrival of the main floodwave. In reality, the response of the channel will be complex with feedback up and down the network. Sediment generated by erosion at upstream locations must pass through lower sites before being lost from the catchment. Temporary storage in the lower channel may alter channel characteristics both locally and upstream, by reducing the water surface gradient and the flow velocity. Adjustment in the planform may take place more slowly than adjustment in the cross-section, and could initiate a subsequent further change in these latter parameters. Overall timescales required for cross-sectional change will also vary depending on the actual sequence of flood events. Vegetative constraints on erosion rates will also be important at some sites. The fact that mean enlargement ratios are generally explicable in terms of simple urban parameters such as the urbanized or sewered percentages, and changes in flood frequency, suggest that the relaxation times involved for most of the change to be accomplished are relatively short, of the order of a few decades, for many British rivers. (See also W90-02963) (Mertz-PTT)
W90-02968

HYDRAULICS OF FLOOD CHANNELS.
Birmingham Univ. (England). Dept. of Civil Engineering.
D. W. Knight.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 83-105. 12 fig, 59 ref.

Descriptors: *Channel morphology, *Geomorphology, *Stage-discharge relations, *Flood channels, *Flood flow, *Flood discharge, Flood spreading, Floods, Open-channel flow, Suspended sediments, Erosion, Sediment transport, Flood routing, Flood plain management.

The hydraulic behavior of flood channels is clearly not a simple matter. The fluid flow is essentially three-dimensional, unsteady and may interact with the boundary. The geomorphological implications of this are that care should be exercised when attempting to quantify the link between either surface erosion or deposition and the fluid flow. The particular problem of out-of-bank flow is a common feature in fluvial systems and of great practical significance in the design of flood alleviation works. The lateral transfer of momentum between the main river channel and the flood plains has been identified as an important phenomenon because it affects not only the distribution of flow parameters but also the sediment fluxes of suspended load onto and off the flood plains. The overall conveyance capacity of a compound channel has been shown to be difficult to determine accurately due to the discontinuity in shape, hydraulic radius and possibly roughness at the main channel/flood plain interface. These combine to significantly affect the stage discharge curve, momentum transfer and friction factors at low flood plain depths. (See also W90-02963) (Mertz-PTT)
W90-02969

FLOW-COMPETENCE EVALUATIONS OF THE HYDRAULIC PARAMETERS OF FLOODS: AN ASSESSMENT OF THE TECHNIQUE.
Oregon State Univ., Corvallis. Coll. of Oceanography.
For primary bibliographic entry see Field 2J.
W90-02970

FLOODS AND FLOOD SEDIMENTS AT RIVER CONFLUENCES.
Birkbeck Coll., London (England).
I. Reid, J. L. Best, and L. E. Frostick.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 135-150. 7 fig, 46 ref.

Descriptors: *Sediment transport, *Rainfall-runoff relationships, *Confluent streams, *Flood flow, *Flood discharge, Flood forecasting, Flood data, Rainfall distribution, Catchment areas, Paleohydrology, Soil water, Storm runoff, Floods, Historic floods, Prediction, Flood profiles.

Confluences are important elements of the drainage network and are points at which flood flows are extremely complex. Nevertheless, several distinct patterns emerge from the discharge records collected at the confluence of two perennial streams. Each pattern is a function of either catchment conditions antecedent to a runoff generating storm, or the uneven distribution of rainfall over contiguous drainage basins. Intrinsic catchment variables are either seasonal, relating to soil moisture deficits, or topographical. Because of this, they are either fixed, or if climatic data are available, they vary predictably. The extrinsic factor of rainfall distribution is not predictable, however. In a temperate setting like the British Isles, the frequency of discrete convective rainfall is low. In contrast, all rain falls from convective cells in tropical settings such as East Africa. Here, the probability that flow will occur in two confluencing rivers simultaneously is low, while the probability of flood waves entering a confluence from each stream in phase is even lower. The non-coincidence of flood flows will be reflected in both the bed morphology and depositional facies. Extensive and rapid changes in bed morphology can be expected within the confluence precinct as a consequence of changing sediment transport patterns as the discharge ratio varies through one flood event. This will also be reflected both in the complexity of the depositional forms and in the composition of sediments which may be represented at these sites. This holds important implications for the paleohydraulic interpretation of channel confluences in ancient sediments. (See also W90-02963) (Mertz-PTT)
W90-02971

FLOOD EFFECTIVENESS IN RIVER BASINS: PROGRESS IN BRITAIN IN A DECADE OF DROUGHT.
Newcastle upon Tyne Univ. (England).
M. D. Newson.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 151-169. 7 fig, 2 tab, 48 ref.

Descriptors: *Sediment transport, *Land forming, *Wales, *Geomorphology, *Erosion, *Floods, *Flood forecasting, *England, Historic floods, Storm runoff, Flood flow, Channel flow, Rainfall intensity.

The role of floods in developing the landscape in Britain is discussed. Britain has not been free of flooding during a decade of drought, though it has been free of disastrous widespread flooding. Possibly the most important flood during the period was that which flooded south Wales in December 1979. Effectiveness and recovery have since been recurring research themes of British floods. The 1973 and 1977 floods on Plynlimon suggested that only rarely did the whole conveyor belt of sediment transport systems in river basins become active in one event. Long, low-intensity rainstorms can wet slopes to the point of failure, but cannot produce

flood peaks to modify channels. Storms of higher intensity produced rapid slope runoff and large channel flows, wrecking low-order channels, but are maintained for too short a period to transport large quantities of material out to piedmont and lowland reaches. A determined and coordinated campaign by all relevant disciplines, but particularly by hydrologists and geomorphologists, to record the impacts of contemporary floods and to review the impacts of historical floods continuously is essential. Possibly the best framework will remain that of special meetings of the relevant learned societies and the publication of proven standard procedures by experienced flood recorders. For the study of flood effectiveness to be effective, much more comprehensive approaches are needed, using large multi-disciplinary teams and maintaining the study for as long as data remain indicative the pattern of response. (See also W90-02963) (Mertz-PTT)
W90-02972

MAGNITUDE AND FREQUENCY OF PALAEOFLOODS.
Arizona Univ., Tucson. Dept. of Geosciences.
V. R. Baker.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 171-183. 7 fig, 2 tab, 29 ref. NSF grants EAR 77-23025, EAR 81-19981, and EAR 83-00183.

Descriptors: *Paleohydrology, *Flood frequency, *Prediction, *Model studies, Floods, Arizona, Salt River, Data interpretation, Frequency analysis.

It has been recognized that palaeoflood data structured by censoring levels results in a type of systematic data set amenable to flood-frequency analysis. Two types of censoring models are well described: event-based censoring and fixed-threshold censoring. Maximum likelihood estimates are used to determine the parameters of a distribution from which floods are assumed to come. This is accomplished by maximizing the probability of observed flood events. In contrast to the weighted moment techniques commonly employed in flood-frequency analysis, maximum likelihood estimates are especially versatile in allowing censored unconventional data sets to be combined with conventional systematic data in an flood-frequency analysis. In examining data on the Salt River in Arizona, it was found that three-parameter distributions at 70% censoring and the two-parameter Gumbel distribution at 95% censoring all gave reasonably consistent flood quantile estimates for return periods ranging from 10 yr to 10,000 yr. Since the Salt River data set includes the largest flood experienced in the last 1000 to 2000 yr, plus the immediately smaller floods in that interval, it is appropriate to estimate the 1000-yr old flood, and to extrapolate with caution to the 10,000-yr flood. This analysis illustrates a change in flood-frequency analysis philosophy posed by the existence of appropriate palaeoflood data. (See also W90-02963) (Mertz-PTT)
W90-02973

USE OF SOIL INFORMATION IN THE ASSESSMENT OF THE INCIDENCE AND MAGNITUDE OF HISTORICAL FLOOD EVENTS IN UPLAND BRITAIN.
Brighton Polytechnic (England). Countryside Research Unit.
R. F. Smith, and J. Boardman.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 185-197. 6 fig, 19 ref.

Descriptors: *Paleohydrology, *Sedimentation, *Flood profiles, *Historic floods, *Floods, *Soil profiles, Soil horizons, England, Erosion, Sediment transport, Soil genesis.

The sedimentary record of large floods in Britain is usually devoid of datable material. Rapid rates of vegetation succession in Britain lead to loss of visual evidence of major events. Assessment of soil profile characteristics such as relative maturity, presence of buried profiles, and evidence of truncation may provide useful evidence of the relative age of erosional and depositional features in river valleys. The valleys of the Porth-Llwyd and Mosedale Beck have broadly similar soil-forming environments. There is little reason to suppose that trends in soil development over time will diverge widely. The A horizons of the Mosedale boulder bar profiles are deeper than the Port-Llwyd profiles. This is consistent with the longer time period of soil formation in Mosedale, over 240 as opposed to 60 years. Soil information may also be of value in the assessment of the lateral extent of flooding in a valley and the extent to which valley side slopes were destabilized as a result of a flood event. In Mosedale, soil investigations in progress suggest that a complex system of anastomosing high-gradient palaeochannels extending to a distance of over 50 m to the east of the present channel may have been formed by a flood event in August 1749. There is a possibility that gaps in the soil record exist. This will depend on the order of high and low-magnitude flood events. A high-magnitude event which succeeds one of lower magnitude is likely to destroy pre-existing soils. (See also W90-02963) (Mertz-PTT)
W90-02974

YELLOW RIVER (COUNTY LEITRIM IRELAND) FLASH FLOOD OF JUNE 1986.
Trinity Coll., Dublin (Ireland). Dept. of Geography.
P. Coxon, C. E. Coxon, and R. H. Thorn.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 199-217. 6 fig, 2 tab, 21 ref.

Descriptors: *Sediment transport, *Channel erosion, *Historic floods, *Yellow River, *Ireland, *Flood damage, *Geomorphology, Bank erosion, Channel stability, Landslides, Braided streams, Flood channels, Mathematical studies, Floods.

The Yellow River flood (in Ireland) was a high-magnitude event with a return period possibly measured in hundreds if not thousands of years. Estimating the scale of the event relies heavily upon palaeo-flood analyses, which in turn rely upon both empirically and theoretically derived equations that contain inherent problems. Some boulder competence equations overestimate flood discharges, but in this case the slope/area method and boulder competence methods produce comparable results, suggesting that the estimates of flood velocity and discharge may be credible. The main geomorphological effects of the Yellow River flood include bank erosion and landsliding, bar production, bar migration and shute formation. None of the chutes have been adopted as permanent channels, although they appear to have been utilized to a limited extent during post-flood high-discharge events. In addition the channel was infilled and raised in low gradient or wider reaches, braiding being initiated in places, and boulder jams were formed in the upper reaches producing steps in the profile. The high rainfall initiated peat slides in the upper part of the catchment. (See also W90-02963) (Mertz-PTT)
W90-02975

RIVER CHANNEL CHANGES IN RESPONSE TO FLOODING IN THE UPPER RIVER DEE CATCHMENT, ABERDEENSHIRE, OVER THE LAST 200 YEARS.
College of St. Paul and St. Mary, Cheltenham (England). Dept. of Geography and Geology.
L. J. McEwen.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 219-238. 5 fig, 1 tab, 38 ref.

Descriptors: *Channel erosion, *Flood frequency, *Floods, *Glaciers, *Scotland, *Dee River, *Channel morphology, *Land use, *Sediment transport, Braided streams, Logging, Paleohydrology.

Within the upper River Dee catchment, the dominant control is the glacial legacy through channel slope, sediment availability, channel confinement and the positioning of local base-levels. The reach's position in terms of process thresholds, its proximity to a quasi-equilibrium condition and the size of the threshold which must be exceeded for planform change to occur are also highly variable. Frequently process rates do not merely represent a direct response to immediate planform controls due to the often transitory nature of the fluvial system. The legacy of past process-response to floods of different magnitudes over a much longer timespan can be important in assessing the controls on channel planform adjustment over a shorter period. It is also important that neither internal nor external thresholds for channel disruption have been recently exceeded as there may be a time-lag before incipient threshold conditions can be attained again. Subsequent more moderated discharges (10-50 years recurrence interval) appear to be more important in returning the channel to a quasi-equilibrium form than disrupting it. However this is not always the case and channel response is highly dependent on both the sequence of floods and planform controls. Both climatic fluctuations and land-use changes have occurred over the 200 year timespan, which are likely to have affected the magnitude and frequency of flooding and sediment mobility, explaining variations in planform response over time. (See also W90-02963) (Mertz-PTT)
W90-02976

SEDIMENTOLOGY AND PALAEOHYDROLOGY OF HOLOCENE FLOOD DEPOSITS IN FRONT OF A JOKULHLAUP GLACIER, SOUTH ICELAND.
Aberdeen Univ. (Scotland). Dept. of Geography.
J. Maizels.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 239-251. 4 fig, 1 tab, 33 ref.

Descriptors: *Sedimentology, *Paleohydrology, *Flood damage, *Historic floods, *Iceland, *Flood flow, *Glacier surges, Flood profiles, Glaciers, Jokulhlaup glaciers, Sediment transport, Volcanoes.

Although major flood events have been relatively rare on Solheimasandur (in Iceland), with only eight recorded in the sedimentary record over a 4000 year period, their effects still dominate the proglacial landscape. These large flows, probably exceeding 10,000 to 100,000 cu m/s, have produced repeated sequences of distinctive, massive, homogeneous, black pumice gravels, characteristic of hyperconcentrated flows, overlain by erosional surfaces, boulder lags, and fluvial bedforms. This common sequence is interpreted as a surge-post-surge flow sequence developed during a complex, volcanically generated jokulhlaup event. Major erosional events occurred during the later flood stages, creating large flood channels and possibly initiating terrace incision. Many problems and uncertainties remain in the interpretation of the wide range of sedimentary structures present in the flood deposits, both in terms of former instantaneous flow conditions, and changes of flow during transport and deposition. The overall approach adopted here may provide a useful framework for the more detailed analysis of flood deposits which have accumulated under a wide range of sediment-fluid flow conditions. (See also W90-02963) (Mertz-PTT)
W90-02977

FLOOD DEPOSITS PRESENT WITHIN THE SEVERN MAIN TERRACE.
M. Dawson.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 253-264. 4 fig, 2 tab, 39 ref.

Descriptors: *Glaciers, *Paleohydrology, *Sedimentation, *Geomorphology, *Flood discharge, *England, *Flood profiles, *Soil horizons, Floods, Flood flow, Flood channels.

Detailed sedimentological analysis of a paraglacial terrace deposit at Holt Heath (England) enabled the identification of a sedimentary horizon atypical

of the sequence as a whole. Examination of this horizon revealed the preservation of channel zone flood bedforms, a reworked overbank area, and waning flow features such as channel fills and an extensive clay drape. On this evidence the unit was interpreted as a flood deposit. Palaeodischarge calculations, although associated with a large range of possible error, indicated that the discharge at Holt Heath was considerable, possibly 2.5 times greater than the present day flood maximum. Episodic high magnitude flow events in modern paraglacial environments have been widely described, associated with sudden discharge fluctuations at the ice margin during deglaciation, and it is thought the sedimentary unit described here is the local consequence of such an event occurring during the initial stages of the deglaciation of the Devensian ice sheet. (See also W90-02963) (Mertz-PTT)
W90-02978

FLOODS IN FLUVIAL GEOMORPHOLOGY.
University Coll. of Wales, Aberystwyth.
J. Lewin.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 265-284. 8 fig, 75 ref.

Descriptors: *Channel morphology, *Geomorphology, *Flood profiles, *Floods, *Flash floods, Model studies, Suspended sediments, Sediment transport.

Some decades of research have now shown that the orthodox model presented earlier is in need of revision and amplification. The role of extreme floods is geographically varied, particularly because of three sets of factors: (1) The relative magnitude of extreme floods, and thus the potential for the incidence and preservation of catastrophic landforms, varies; (2) Physiographic factors are significant in that they involve flood-flow generation, contrasted slope instability conditions, the potential for preserving the effects of floods selectively, and different sedimentary environments which may respond to extreme flows in a variable manner; and (3) Sediments have generally to be considered more systematically. Such factors make the study of floods in fluvial geomorphology more difficult even than they once appeared. In the future it may perhaps be helpful to appreciate that research needs to be conducted in at least five rather contrasted geomorphological settings: headwater environments, bedrock gorges, channel metamorphosis, lateral accretion environments, and accretion catastrophe. (See also W90-02963) (Mertz-PTT)
W90-02979

COMPUTATIONAL METHODS IN WATER RESOURCES: VOL. 1. MODELING SURFACE AND SUB-SURFACE FLOWS.
For primary bibliographic entry see Field 7C.
W90-02980

SOME EXAMPLES OF INTERACTION OF NUMERICAL AND PHYSICAL ASPECTS OF FREE SURFACE FLOW MODELLING.
CEFRHYG, Grenoble (France).
J. A. Cunge.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 3-12, 4 fig, 9 ref.

Descriptors: *Model studies, *Surface flow, *Hydrologic models, *Open-channel flow, *Mathematical models, Free surfaces, Computer models, Computer programs, Numerical analysis, Hydraulic models.

In the near future most mathematical models of free surface flows will be run in the same way that computer-aided design (CAD) software is used for structures. This prospect means that software developers must provide safe simulation codes including not only numerical solution of equations

but analysis of physical and computational features and operating aids. Simplified one-dimensional equations or 'Muskingum' and a two-dimensional finite difference scheme (de Saint-Venant equations) are discussed to demonstrate that, despite 30 yr of use of mathematical models, gray areas still exist in the solution of open-channel flow problems. It is concluded that progress in user-friendly interfaces (especially graphical input-output processors) must not hide the need for combined hydraulic and numerical competence, which is necessary to build such systems and interpret their results. (See also W90-02980) (Rochester-PTT)
W90-02981

VARIABLY SATURATED FINITE-ELEMENT MODEL FOR HILLSLOPE INVESTIGATIONS.
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
S. T. Potter, and W. J. Gburek.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 127-132, 4 fig, 10 ref.

Descriptors: *Statistical models, *Rainfall-runoff relationships, *Model studies, *Pennsylvania, *Storm runoff, *Surface-groundwater relations, *Galerkin method, Finite element method, *Hydrologic models, Slopes, Mathematical equations, Richard equation, Variable contributing area, Simulation, Performance evaluation.

The variable-contributing-area concept (VCA) of storm runoff production is based on the hypothesis that stream response to precipitation is governed by inseparable surface-groundwater interactions. The present study aimed to develop a state-of-the-art subsurface flow model capable of characterizing the highly dynamic and strongly nonlinear groundwater flow that occurs during a storm runoff event according to the VCA model. A Galerkin finite-element model of Richard's equation was formulated using C1 continuous Hermitian bases to approximate total head; serendipity Hermitian bases were used for hydraulic conductivity and specific moisture capacity. These bases were imposed on curved, isoparametric, quadrilateral subspaces restricted to orthogonal corners. The model's ability to simulate subsurface response to a storm event was tested using a hypothetical hillslope of 200-ft cross-section, with a maximum slope on the land surface of 27%. Parameters were chosen for this system and for the storm event that were consistent with conditions in the central Pennsylvania ridge and valley region. The model was run using time steps of 10 min, with lumping necessary to ensure stability. Due to the length of the flow system and the relatively low value of hydraulic conductivity (1.0 ft/day) compared to the simulation time, only near-stream subsurface flow played a critical role during the storm. Groundwater response from 0 to 60 minutes was displayed as vectors representing specific discharge. Although the transient response of moisture on a given hillslope can be so dynamic as to preclude physical characterization in the field, simulation of the system in a comprehensible, defensible, mathematical model may yield a rational explanation of phenomena and more complete understanding of the important processes may be realized. (See also W90-02980) (Rochester-PTT)
W90-02998

SUPERCOMPUTER SIMULATIONS OF HETEROGENEOUS HILLSLOPES.
Lancaster Univ. (England). Dept. of Environmental Sciences.
A. Binley, K. Beven, and J. Elgy.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 185-190, 2 fig, 10 ref.

Descriptors: *Infiltration, *Rainfall-runoff relationships, *Model studies, *Supercomputers, *Hydrologic models, *Computer programs, *Slopes, *Numerical analysis, *Simulation, Runoff, Saturated flow, Mathematical studies, Finite element method, Storm seepage, Galerkin method, Hydraulic conductivity, Vector processing, Heterogeneity.

A fully three-dimensional model of variably saturated flow has been developed to investigate the hydrologic effects of spatial variability of saturated hydraulic conductivity on a 150-m x 100-m hillslope and assess the validity of the concept of effective hydraulic conductivity. The model is based on the Galerkin approximation of the finite element method. Accessibility to the vector processor of a CDC Cyber 205 supercomputer permitted numerical solutions on grids containing several thousand node points and two thousand time steps. The present results suggest that, under conditions of hydrograph domination by subsurface flow (either seepage or return flow), the concept of an equivalent uniform hillslope may be valid. Although a perfect match is unlikely, close agreement between heterogeneous and homogeneous responses appears plausible under a range of external conditions. The definition of the uniform property in terms of the underlying distribution parameters still requires investigation. A value greater than the geometric mean and close to the arithmetic mean was the optimum value for the single realization of variability considered here. Such a value complements the results of previous investigations in simpler flow systems. (See also W90-02980) (Rochester-PTT)
W90-03006

CONSISTENCY ANALYSIS OF THE FEM: APPLICATION TO PRIMITIVE AND WAVE EQUATIONS.
Princeton Univ., NJ. Dept. of Civil Engineering.
J. Drolet, and W. G. Gray.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 225-230, 1 fig, 2 tab, 12 ref.

Descriptors: *Finite element method, *Mathematical models, *Mathematical studies, *Waves, *Mathematical equations, Taylor series, Spatial distribution, Surface water, Fourier analysis, Consistency analysis, Comparison studies, Performance evaluation.

The order of consistency is a direct measure of the speed at which a model converges to the exact solution as the elements become finer. The Taylor series expansion has proven to be a reliable tool for proving the consistency of approximations over regular meshes. However, approximation over irregular or scattered grids may require a slightly more sophisticated tool to show consistency. Such a tool was developed and is presented; it makes use of a Fourier transform and leads to a modified equation. Equations for primitive momentum, wave continuity, and wave momentum were employed in demonstrating the new consistency method. Four spatial discretizations were considered. The first is a hexagonal arrangement containing six identical isoceles triangles. Then, two arrangements arising when deriving a triangular grid from a rectangular grid were analyzed individually, and a fourth arrangement derived from the interaction of these two arrangements was studied. The method used allowed for the analysis of an approximation of several nodes simultaneously, thus considering consistency in a global sense. The method was applied successfully to some well-known approximations of primitive and wave equations. Although some of these approximations have local truncation errors of an order less than one, the alternative consistency analysis method showed them to be consistent in a global sense. These results agreed with numerical experiments. (See also W90-02980) (Rochester-PTT)
W90-03012

Group 2E—Streamflow and Runoff

SHALLOW WATER WAVE EQUATIONS ON A VECTOR PROCESSOR.
Notre Dame Univ., IN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W90-03015

TESTING OF FINITE ELEMENT SCHEMES FOR LINEAR SHALLOW WATER EQUATIONS.
Vatnaskil, Reykjavik (Iceland).
For primary bibliographic entry see Field 2H.
W90-03016

SYSTEM IDENTIFICATION AND SIMULATION OF CHESAPEAKE BAY AND DELAWARE BAY CANAL HYDRAULIC BEHAVIOR.
Maryland Dept. of Natural Resources, Annapolis.
For primary bibliographic entry see Field 2L.
W90-03025

IMPLICIT FACTORED SCHEME FOR THE SIMULATION OF ONE-DIMENSIONAL FREE SURFACE FLOW.
Mexican Inst. of Water Technology, Jiutepec.
A. A. Aldama, J. Aparicio, and C. Espinosa.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 345-350, 1 fig, 5 ref.

Descriptors: *Surface flow, *Model studies, *Free surfaces, *Simulation, *Open-channel flow, Numerical analysis, Mathematical equations, Galerkin method, Finite element method, Hydrographs, Computer programs, Computer models, Hydraulic models.

One of the main difficulties associated with the numerical simulation of one-dimensional, free surface flow is the presence of nonlinearities in the governing equations. These nonlinearities make it necessary to perform iterations whenever a conventional implicit-time integration scheme is used. A second order accurate, noniterative implicit scheme was developed for the numerical solution of the governing equations for one-dimensional free surface flow. It is presented here with an example. A Galerkin finite-element formulation with quadratic expansions was used for space discretization. A rectangular channel 1 km long and 2 m wide, with a bottom slope of 0.0002 was considered. The channel receives a hydrograph at the upstream boundary while a constant depth is maintained at the downstream boundary. Values of change in spatial coordinate (delta x) of 10 m and change in time (delta t) of 60, 120, 240, and 360 seconds were used. The downstream hydrograph results were similar for all values of delta t. The implicit-factored scheme is very suitable for one-dimensional free-surface flow simulation. Flow simulation with this method, because it eliminates the need for iterations, saves considerable CPU time. (See also W90-02980) (Rochester-PTT)
W90-03029

COMPUTING 2-D UNSTEADY OPEN-CHANNEL FLOW BY FINITE-VOLUME METHOD.
Demokritos Univ. of Thrace, Xanthi (Greece). Dept. of Civil Engineering.
C. V. Bellos, J. V. Soulis, and J. G. Sakkas.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 357-362, 4 fig, 4 ref.

Descriptors: *Unsteady flow, *Statistical methods, *Open-channel flow, *Hydrologic models, *Flood waves, *Dam failure, Free surfaces, Finite element method, Finite difference methods, Mathematical models, Model studies, Simulation, Performance evaluation.

The computation of a two-dimensional flood wave resulting from the instantaneous break of a dam is considered. For a rectangular computational grid, the flow equations require a specific finite difference formulation in the flow area close to the solid boundaries. This leads to numerical approximations that cannot represent accurately the flow characteristics in the area near the boundaries. In particular, in two-dimensional free-surface flow computations, the difficulties and inaccuracies associated with the determination of flow characteristics near these boundaries are well known. An attempt has been made to overcome the aforementioned difficulties. The general technique used is a combination of the finite-element and the finite-difference method. First, a transformation is introduced through which quadrilaterals in the physical domain are mapped into squares in the computational domain. The governing system of equations is thus transformed into an equivalent system applied over a square-grid network. Second, the McCormack explicit finite difference numerical scheme is used for the solution of the transformed state of equations. This two-step (predictor-corrector) scheme has been proved to be well suited for flow computations where discontinuities may be present. The approach described above has been applied for the computation of the propagation of a flood wave resulting from the instantaneous break of a dam. Comparison between computed and experimental data shows a satisfactory agreement. The most important prospect of the method lies in its capability to facilitate computation of unsteady flows in natural (irregular) channels using a relatively simple method of finite differences. (See also W90-02980) (Author's abstract)
W90-03031

EULERIAN-LAGRANGIAN LINKED ALGORITHM FOR SIMULATING DISCONTINUOUS OPEN CHANNEL FLOWS.
Inland Waters Directorate, Burlington (Ontario).
S. M. A. Moin, D. C. L. Lam, and A. A. Smith.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 363-368, 4 fig, 5 ref.

Descriptors: *Simulation, *Open-channel flow, *Computer models, *Model studies, *Flood waves, *Discontinuities, Finite element method, Finite difference methods, Galerkin method, Eulerian method, Lagrangian method, Comparison studies, Precision, Algorithms.

Standard finite-difference (FD) and finite-element (FE) methods result in poor and unsatisfactory solutions for near discontinuous open channel flows. The presence of oscillatory waves in the proximity of the discontinuous region commonly is addressed by adding external or internal dissipating mechanisms. A space-time FE method based on the Galerkin formulation of the divergent form of the open channel flow equations is presented (the 'moving element' or ME method). The proposed Eulerian-Lagrangian linked algorithm demonstrates remarkable shock capturing properties while maintaining a high order of accuracy. No extraneous parameters are required to dissipate the parasitic oscillations. Results are presented for flow conditions that lead to the formation of discontinuity and shocks (supercritical flood wave in a frictionless channel and subcritical surge in a frictionless channel). The improvement over other techniques is demonstrated by comparing the solution with FE and FD methods. The Eulerian-Lagrangian-based ME method is superior to any other technique in the purest form (i.e., without adding diffusion terms or by advancing the Crank-Nicholson centered weighting). The Lagrangian scheme alone does not provide for a non-dissipative interface; dissipation is provided by the Eulerian regridding. (See also W90-02980) (Author's abstract)
W90-03032

TAYLOR WEAK STATEMENT CFD ALGORITHM FOR FREE SURFACE HYDROMECHANICAL FLOWS.
Tennessee Univ., Knoxville.
A. J. Baker, and G. S. Iannelli.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 77-82, 1 fig, 9 ref.

Descriptors: *Mathematical studies, *Unsteady flow, *Open-channel flow, *Critical flow, *Transition flow, *Fluid mechanics, Estuaries, Shallow water, Algorithms, Energy, Navier-Stokes equations, Mathematical equations, Free surfaces, Taylor series, Errors, Performance evaluation, Computer programs.

A finite element computational fluid dynamics (CFD) algorithm is established for the two-dimensional, unsteady depth-averaged free surface Navier-Stokes equations for an incompressible isoenergetic flow. The governing equation set is cast in hyperbolic conservation law form, whereupon a temporal Taylor series is utilized to establish truncation error terms. The resulting Taylor weak statement embeds functional expressions dominating dispersion and dissipation error mechanisms of the semi-discrete approximation. Theoretical analyses document algorithm accuracy and stability for the linear trial basis implementation. An efficient numerical linear algebra procedure has been derived and implemented into computer code. Numerical results verify code performance for prototype estuarine geometries, including significantly separated flows. (See also W90-03036) (Author's abstract)
W90-03048

NUMERICAL SIMULATION OF THE VORTEX SHEDDING PROCESS PAST A CIRCULAR CYLINDER.
A. Giorgini, and G. Alfonsi.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 83-88, 3 fig, 3 ref.

Descriptors: *Simulation, *Mathematical studies, *Flow around objects, *Turbulent flow, *Vortices, *Numerical analysis, Finite difference methods, Navier-Stokes equations, Mathematical equations, Fourier transforms, Matrix inversion method, Computer programs, Streamlines.

A computational analysis is performed on the two-dimensional, time dependent Navier-Stokes equations in their stream function-vorticity transport form. The equations are cast in log polar coordinates and the fields are expanded in Fourier series along the azimuthal coordinate. The numerical techniques used for the computations are finite differences for the time advancement, fast Fourier transform to perform the convolutions resulting from the convective terms, and matrix inversion method for the radial integration. To simulate the vortex shedding process, a perturbation, consisting in a pure rotational field, has been imposed to the initially irrotational flow at time $t = 0$. The perturbation vortex is characterized by two quantities, the strength and the spread, both depending on the values of two parameters, C and n. The results presented here correspond to the values $C = 0.009$ and $n = 3.44$. The results are illustrated by means of computer-generated drawings of the flow fields in terms of absolute streamlines, relative streamlines, and vorticity. The results of the calculations are shown up to the nondimensional time $t = 40$ and the sequence of birth and detachment of primary vortices is clearly visible in terms of absolute streamlines, relative streamlines and vorticity from the computer generated drawings provided. (See also W90-03036) (Author's abstract)
W90-03049

NUMERICAL INVESTIGATION OF TURBULENT FLOW FIELD IN A CURVED DUCT WITH AN ALTERNATING PRESSURE DIFFERENCE SCHEME.
Xian Jiaotong Univ. (China). Dept. of Power Me-

chanical Engineering.
For primary bibliographic entry see Field 8B.
W90-03050

TURBULENT DIFFUSION SIMULATION BY
IMPLICIT FACTORED SOLVER USING K-EP-
SILON MODEL.
Florence Univ. (Italy). Dept. of Energy Engineer-
ing.
For primary bibliographic entry see Field 5B.
W90-03051

ADAPTIVE COLLOCATION FOR BURGERS'
EQUATION.
Wyoming Univ., Laramie.
For primary bibliographic entry see Field 8B.
W90-03054

NUMERICAL ANALYSIS OF TRANSIENTS IN
COMPLEX HIDROPOWER SCHEME.
Eletrosul, Florianopolis (Brazil).
For primary bibliographic entry see Field 8B.
W90-03086

SOME ASPECTS OF KALMAN FILTERING
APPLICATION IN HYDROLOGIC TIME
SERIES PROCESSING.
Institut za Vodoprivredu Jaroslav Cerni, Belgrade
(Yugoslavia).
M. Markus, and D. Radojevic.
IN: Computational Methods in Water Resources,
Vol.2: Numerical Methods for Transport and Hy-
drologic Processes. Elsevier, New York. 1988. p
351-356, 3 fig, 6 ref.

Descriptors: *Mathematical models, *Forecasting,
*Yugoslavia, *Gaging stations, *Hydrologic
models, *Stream discharge, *Danube River, *Time
series analysis, Kalman filtering, Forecasting, ARX
model, Error analysis, Mathematical models, Re-
gression analysis.

A procedure of hydrological forecasting using the
linear ARX model and Kalman filtering is present-
ed. Model parameters were determined adaptively.
The application of Kalman filter techniques leads
to autoregression and cross-regression coefficients
estimates after each time increment. The model
was applied to two gaging stations on the Danube
River in Yugoslavia. The standard forecasting
error of the ARX model was 97 cu m/sec without
Kalman filtering and 79 cu m/sec with it, repre-
senting a 19% reduction in error due to Kalman
filtering. The recursive adaptive procedure usually
is superior to conventional non-recursive methods.
By updating the state of the hydrological system
with new information, time-varying parameter esti-
mates are obtained. These parameters, after several
steps of computation, usually tend to converge on
some constant values. A good hydrologic forecast
can be obtained by using the best input parameters
in the model. (See also W90-03036) (Rochester-
PTT)
W90-03087

COMPUTER MODEL FOR THE ESTIMATION
OF EFFLUENT STANDARDS FOR PRIORITY
POLLUTANTS FROM A WASTEWATER DIS-
CHARGE BASED UPON AQUATIC LIFE CRI-
TERION OF THE RECEIVING STREAM.
For primary bibliographic entry see Field 5G.
W90-03088

IDENTIFICATION OF IUH ORDINATES
THROUGH NON-LINEAR OPTIMIZATION.
Universidad Nacional Autonoma de Mexico,
Mexico City. Water Resources Program.
J. A. Raynal Villasenor, and D. F. Campos
Aranda.
IN: Computational Methods in Water Resources,
Vol.2: Numerical Methods for Transport and Hy-
drologic Processes. Elsevier, New York. 1988. p
385-390, 1 fig, 3 tab, 5 ref.

Descriptors: *Flood forecasting, *Streamflow fore-
casting, *Unit hydrographs, *Optimization, *Hy-
drologic models, Algorithms, Errors, Computer
programs, Performance evaluation.

The process of identification of ordinates of the
instantaneous unit hydrograph (IUH) is an impor-
tant step in its application to forecast river flow.
The process itself has several interesting features,
including the appearance of the overestimation
condition, which occurs when more equations than
variables exist, and undesirable outcomes, such as
negative ordinates and oscillations. To avoid these
problems, several approaches based on optimiza-
tion techniques have been proposed that use linear,
quadratic, or non-linear optimization. In the
present study, the non-linear optimization is used
to construct a procedure for identification of IUH
ordinates. The procedure, known as MINIMSE
(for minimize the mean square error), achieves
better overall results in obtaining IUH ordinates
than do two other procedures (MINIMAD, mini-
mize the maximum absolute deviation, and MINI-
SAD, minimize the sum of absolute deviations).
The proposed methodology is characterized by
simplicity of problem formulation and computer
code design. (See also W90-03036) (Rochester-
PTT)
W90-03092

NUMERICAL ASPECTS OF SIMULATION
AND OPTIMIZATION MODELS FOR A COM-
PLEX WATER RESOURCES SYSTEM CON-
TROL.
Institut za Vodoprivredu Jaroslav Cerni, Belgrade
(Yugoslavia).
For primary bibliographic entry see Field 3F.
W90-03093

OPTIMAL OPERATION OF A RESERVOIR
SYSTEM WITH NETWORK FLOW ALGO-
RITHM.
Universidade Estadual de Campinas (Brazil). Dept.
de Engenharia de Sistemas.
For primary bibliographic entry see Field 4B.
W90-03094

RELIABILITY CONSTRAINED MARKOV DE-
CISION PROGRAMMING AND ITS PRACTI-
CAL APPLICATION TO THE OPTIMIZATION
OF MULTIPURPOSE RESERVOIR REGULA-
TION.
Tsinghua Univ., Beijing (China). Dept. of Hydrau-
lic Engineering.
For primary bibliographic entry see Field 4A.
W90-03097

OPTIMAL MULTIOBJECTIVE OPERATION-
AL PLANNING OF A WATER RESOURCES
SYSTEM.
Universidade Estadual de Campinas (Brazil). Dept.
de Engenharia de Sistemas.
For primary bibliographic entry see Field 4A.
W90-03098

RELIABLE SYSTEM SOFTWARE FOR THE
MICRO-PROCESSOR BASED HYDROMETER-
OLOGICAL NETWORK FOR REAL TIME
STREAM FLOW AND FLOOD FORECASTING
IN NARMADA BASIN IN INDIA.
Narmada Control Authority, Bhopal (India).
R. S. Varadarajan.
IN: Computational Methods in Water Resources,
Vol.2: Numerical Methods for Transport and Hy-
drologic Processes. Elsevier, New York. 1988. p
459-466, 2 ref.

Descriptors: *Model studies, *India, *Flood fore-
casting, *Computer programs, *Network design,
Hydroelectric power, Irrigation, Hydrologic
models, Satellite technology, Telecommunications,
Mathematical models, Narmada River Basin.

A real time computer system is used in many
situations where an immediate response is desired,
whether in business or in various hydrologic appli-
cations such as flood and streamflow forecasting.
The computer systems required for a proposed real
time hydrologic network for the Narmada River
Basin, India, are discussed, including functions to
be performed by the system, software require-
ments, and reliability. Fifty-six hydrometeorologi-
cal stations associated with irrigation and power

project sites are to be involved in the system. Data
communication is to be by a satellite-UHF-VHF
telecommunications connection. Mathematical
models and data from an operational data bank
would be used in real time forecasting. High reli-
ability is a very important priority in the proposed
network. Software will include system diagnostics,
recovery from failure, backup and file transfer
utilities, and system accounting. (See also W90-
03036) (Rochester-PTT)
W90-03103

RAINFALL-RUNOFF TRANSFER FUNCTION
BY ARMA MODELING.
Marquette Univ., Milwaukee, WI. Dept. of Civil
Engineering.
V. Novotny, and S. Zheng.
Journal of Hydraulic Engineering (ASCE)
JHEND8, Vol. 115, No. 10, p 1386-1400, Oct 1989.
9 fig, 1 tab, 21 ref.

Descriptors: *Statistical analysis, *Regression anal-
ysis, *Model studies, *Rainfall-runoff relationships,
*Mathematical models, *Unit hydrographs, *Hye-
tographs, Urban runoff, Watersheds, Surface
runoff, Storm seepage, Hydrologic models, Stor-
age, Water conveyance.

The unit hydrograph is a runoff hydrograph result-
ing from a unit volume-short-duration excess rain-
fall. It is used for overland routing of the rainfall
excess--hence it is used for determining runoff rates
from rainfall hyetographs. Deterministic unit hy-
drographs have been used by hydrologists for
more than fifty years. A unit hydrograph is essen-
tially a watershed rainfall-runoff linear transfer
function (TF). Determination of the deterministic
unit hydrograph is very difficult due to the need
for separation flows into surface and subsurface
runoff components, elimination of noise present in
the data series, and inherent inadequacies of the
deterministic deconvolution methods being applied
to data series 'corrupted' by autocorrelation of the
data and moving average random inputs. The
paper presents a simple methodology for separa-
tion of the unit hydrograph function from rainfall
and runoff time series which is based on autor-
egressive-moving average (ARMA) transfer func-
tion modeling. By converting the nonlinear
ARMA transfer function model into a linear ex-
tended autoregressive (AR) transfer function
model, the coefficients of the model can easily be
estimated by linear multiple regression followed by
filtering the transfer function. The methodology is
illustrated on actual time series of flows and rain-
falls from two sewer systems. The transfer function
model can be used for forecasting and real-time
operational control of drainage systems, especially
those located in urban or industrialized areas. It
appears that the accuracy of the forecasts using
these relatively simple models matches or even
surpasses those made by far more complex deter-
ministic models. The methodology for the AR-TF
unit hydrograph determination may have a wide
range of applications such as infiltration-inflow
analysis, dry weather/wet weather flow separa-
tion, real-time forecasting, quality analyses, and
classic hydrologic design of storage and convey-
ance systems. (Author's abstract)
W90-03223

SCOUR-DEPTH PREDICTION UNDER AR-
MORING CONDITIONS.
Cook Coll., New Brunswick, NJ. Dept. of Biologi-
cal and Agricultural Engineering.
For primary bibliographic entry see Field 2J.
W90-03225

STUDY, USE, AND PROTECTION OF SMALL
AND MEDIUM RIVERS.
For primary bibliographic entry see Field 6G.
W90-03253

BED-LOAD DISCHARGE OF A CHANNEL
FLOW WITH WIND WAVES.
For primary bibliographic entry see Field 8B.
W90-03255

Group 2E—Streamflow and Runoff

FLORISTIC AND VEGETATIONAL OVERVIEW OF REELFOOT LAKE.
Tennessee Dept. of Conservation, Nashville. Div. of Ecological Services.
For primary bibliographic entry see Field 2H.
W90-03266

AQUATIC VASCULAR FLORA AND PLANT COMMUNITIES ALONG RIVERS AND RESERVOIRS OF THE TENNESSEE RIVER SYSTEM.
Tennessee Valley Authority, Muscle Shoals, AL.
For primary bibliographic entry see Field 2H.
W90-03267

COST-EFFECTIVE SELECTION OF CULVERTS FOR SMALL FOREST STREAMS.
New Zealand Forest Service, Rotorua. Forest Research Inst.
For primary bibliographic entry see Field 8A.
W90-03316

CONSTRAINED MEDIAN STATISTICAL ROUTING METHOD AND THE PECOS RIVER CASE.
Texas Univ. at Austin. Center for Cybernetic Studies.
For primary bibliographic entry see Field 6D.
W90-03321

INTERFACIAL MIXING IN STRATIFIED CHANNEL FLOWS.
Nebraska Univ.-Lincoln. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W90-03331

ACOUSTIC MEASUREMENT OF RIVER DISCHARGE.
RD Instruments, San Diego, CA.
For primary bibliographic entry see Field 7B.
W90-03333

LIMITATIONS OF DE SAINT VENANT EQUATIONS IN DAM-BREAK ANALYSIS.
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
D. R. Basco.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 7, p 950-965, July 1989. 10 fig, 26 ref.

Descriptors: *Flood forecasting, *Dam failure, *Dams, *Mathematical models, *Flood forecasting, Numerical analysis, Wave action, Landslides, Rapid flow.

The flood wave resulting from the sudden release of water due to a dam failure has been routinely modeled by the gradually varied, unsteady free surface flow equations of de Saint Venant. One key assumption is that streamline curvature effects are small, so that the pressure distribution is hydrostatic. A short time after dam collapse, rapidly varied regions characterized by large streamline curvatures can produce nonhydrostatic distributions that may be important additional effects in the momentum balance. The equations of de Saint Venant were extended to incorporate streamline curvature effects, and a higher-order-accurate, finite difference analog numerical model was developed using these de Saint Venant equations and the more general Boussinesq equations. Numerical results were compared with an excellent data set from laboratory measurements made by the USAE Waterways Experiment Station. Solitary waves of various wave 'periods' were propagated down a horizontal, frictionless channel, and sets of laboratory-scale, dam-break experiments of a sloping bed with boundary resistance were simulated with both systems. Both the de Saint Venant and Boussinesq equations gave very similar results, except for very short-period waves below about 100 sec. Since prototype-scale flood waves created by dam breaches are all of much longer duration, we may tentatively conclude that the de Saint Venant equations are more than adequate to capture the

physics of these events. Free surface flow disturbances generated by landslides in deep reservoirs, rapid releases below power plants, and other short-wave phenomena in canals are also of interest and concern for hydraulic engineers. (Ence-PTT)
W90-03335

SPILLWAY DISCHARGE CALCULATIONS IN NWS DAMBRK.
Army Engineer Div. North Pacific, Portland, OR.
For primary bibliographic entry see Field 8B.
W90-03337

PRESSURE RECOVERY IN DIVIDING OPEN CHANNELS.
Technical Univ. of Nova Scotia, Halifax.
For primary bibliographic entry see Field 8B.
W90-03340

WEST AFRICAN RIVERS AS BIOGEOGRAPHIC ISLANDS: SPECIES RICHNESS OF FISH COMMUNITIES.
Laboratoire d'Ichtyologie Generale et Appliquee, Paris (France).
For primary bibliographic entry see Field 2H.
W90-03345

HEAVY METAL ANALYSIS IN FISH-KILL CASES IN RIVERS IN GUIPUZCOA (SPAIN).
Universidad del Pais Vasco, San Sebastian (Spain). Lab. Contaminacion.
For primary bibliographic entry see Field 5C.
W90-03352

AQUATIC HYPHOMYCETE COMMUNITIES IN CLEAR-CUT AND WOODED AREAS OF AN ILLINOIS STREAM.
Illinois Univ. at Urbana-Champaign. Dept. of Plant Biology.
For primary bibliographic entry see Field 4C.
W90-03383

RIVER-MEANDER MODEL: I. DEVELOPMENT.
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
A. J. Odgaard.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 11, p 1433-1450, November 1989. 3 fig, 43 ref. NSF Grant MSM-8308470.

Descriptors: *Channel morphology, *Geomorphology, *Model studies, *River flow, *Meanders, *Alluvial channels, *Channel flow, *Bank erosion, *Mathematical models, Streambeds, Sediments.

Meander flow and meander-planform development are described. The basis is a steady, two-dimensional model of flow and bed topography in an alluvial channel with variable curvature. The model is developed from the equations for conservation of mass (water and sediment) and momentum, and from a stability criterion for sediment particles on the stream bed. By order of magnitude considerations and linearization, these equations are reduced to those of a damped, oscillating system. The meander development is described by forcing a traveling, small-amplitude channel alignment wave on the system, and determining the growth characteristics of the wave. The growth rate of the amplitude is determined by relating the alignment wave and the change in channel alignment through bank-erosion model. Formulas are thereby developed for calculation of: (1) velocity and depth distribution in meandering channels, and (2) rate and direction of channel migration. Laboratory and field data are used to verify the formulas. (See also W90-03394) (Author's abstract)
W90-03393

RIVER-MEANDER MODEL: II. APPLICATIONS.
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
A. J. Odgaard.
Journal of Hydraulic Engineering (ASCE)

JHEND8, Vol. 115, No. 11, p 1451-1464, November 1989. 9 fig, 2 tab, 14 ref. NSF grant MSM-8308470.

Descriptors: *Channel morphology, *Geomorphology, *Model studies, *River flow, *Meanders, *Alluvial channels, *Channel flow, *Bank erosion, *Mathematical models.

An analytical model for the description of flow and bed topography in, and planform development of meanders is tested with data from rivers in India, Pakistan, and the U.S. The model is steady, two-dimensional and linear, and it describes the channel flow as a damped, oscillating system with curvature as forcing function. The description of planform development is obtained by forcing a small, traveling perturbation on the system and determining the migration features of the perturbation. The model describes planform development in terms of lateral and downstream migration rates, and flow and bed topography in terms of transverse gradients of depth and depth-averaged velocity. Formulas for estimates of dominant meander wavelength and phase shift are also tested. The agreement with data is good. Guidelines for the use of the model are described, using data from a hypothetical river. (See also W90-03393) (Author's abstract)
W90-03394

DAM-BREAK FLOWS IN CURVED CHANNEL.
Snohomish County Dept. of Public Works, Everett, WA. Surface Water Management Section.
For primary bibliographic entry see Field 8B.
W90-03395

TURBULENT VELOCITY PROFILES FOR SMOOTH AND ROUGH OPEN CHANNEL FLOW.
Cukurova Univ., Adana (Turkey). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-03398

ESTIMATING PROBABILITIES OF EXTREME RAINFALLS.
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2B.
W90-03399

APPLICABILITY INDEX FOR SAND TRANSPORT EQUATIONS.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 2J.
W90-03400

DILUTION DISCHARGE MEASUREMENT DURING FLOOD WAVE.
Technische Hogeschool Delft (Netherlands). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W90-03401

RISK ESTIMATION IN PARTIAL DURATION SERIES.
Technical Univ. of Denmark, Lyngby. Inst. of Hydrodynamics and Hydraulic Engineering.
P. F. Rasmussen, and D. Rosbjerg.
Water Resources Research WRERAQ, Vol. 25, No. 11, p 2319-2330, November 1989. 11 fig, 1 tab, 7 ref, 2 append.

Descriptors: *Design floods, *Flood data, *Flood frequency, *Stochastic models, Monte Carlo method, Simulation, Flood forecasting.

The estimation of design floods is, in practice, often based on small samples of data, which may cause a severe uncertainty. For a particular version of the partial duration series (exponentially distributed exceedances and Poissonian occurrence times) the distribution of the T-year design estimate x-sub-T is derived along with the distribution of R-

sub-T, defined as the true risk of exceeding x-sub-T within a given disposal period. For a fixed flood level the distributions of the return period estimator T and the estimator of the risk in lifetime R are also presented. Analytical closed-form expressions for mean value and standard deviation were derived for these variables, except for T, which does not possess moments. The concept of 'expected risk' is introduced, and an analytical expression describing this property is derived. A risk-based design technique, which is essentially different from the traditional procedure, is presented, and its applicability is verified using Monte Carlo simulation. (Author's abstract)
W90-03420

GIARDIA CYST CONCENTRATIONS IN RIVER WATER.
Washington Univ., Seattle. Dept. of Environmental Health.
For primary bibliographic entry see Field 5B.
W90-03472

AMAZON RIVER DISCHARGE AND CLIMATE VARIABILITY: 1903 TO 1985.
Washington Univ., Seattle. School of Oceanography.
J. E. Richey, C. Nobre, and C. Deser.
Science SCIEAS, Vol. 246, No. 4926, p 101-103, October 6, 1989. 3 fig, 26 ref.

Descriptors: *Amazon River, *River flow, *El Nino/Southern Oscillation, *Climates.

Reconstruction of an 83-year record (1903-1985) of the discharge of the Amazon River shows that there has been no statistically significant change in discharge over the period of record and that the predominant interannual variability occurs on the 2-year to 3-year time scale. Oscillations of river discharge predate significant human influences in the Amazon basin and reflect both extrabasinal and local factors. Cross-spectrum analysis of Amazon flow anomalies with indicators of the El Nino-Southern Oscillation phenomenon suggest that the oscillations in the hydrograph are coupled to the tropical Pacific climate cycle. (Author's abstract)
W90-03475

EFFECT OF STREAM REGULATION ON POPULATION PARAMETERS OF ATLANTIC SALMON (SALMO SALAR L.) IN THE RIVER LAERDALSELVA, WESTERN NORWAY.
Oslo Univ. (Norway). Lab. for Freshwater Ecology and Inland Fisheries.
For primary bibliographic entry see Field 6G.
W90-03508

CHINOOK SALMON SPAWNING SURVEYS IN DEEP WATERS OF A LARGE, REGULATED RIVER.
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
For primary bibliographic entry see Field 2H.
W90-03509

INDEX OF SURFACE-WATER STATIONS IN TEXAS, JANUARY 1989.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7B.
W90-03542

2F. Groundwater

COMBINING FLOW SIMULATION AND OPTIMIZATION FOR DYNAMIC MANAGEMENT OF RELIEF WELLS.
Alberta Environment, Edmonton. Technical Services Div.
For primary bibliographic entry see Field 4B.
W90-02548

HYDROLOGIC EFFECTS ON WATER LEVEL CHANGES ASSOCIATED WITH EPISODIC

FAULT CREEP NEAR PARKFIELD, CALIFORNIA.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 7B.
W90-02577

INFLUENCE OF FORMATION MATERIAL PROPERTIES ON THE RESPONSE OF WATER LEVELS TO EARTH TIDES AND ATMOSPHERIC LOADING.
Geological Survey, Menlo Park, CA.
S. Rojstaczer, and D. C. Agnew.
Journal of Geophysical Research (B) JJGBDU, Vol. 94, No. 9, p 12,403-12,411, September 10, 1989. 6 fig, 3 tab, 37 ref, 2 append.

Descriptors: *Geohydrology, *Water table fluctuations, *Water level fluctuations, *Tidal effects, *Atmospheric pressure, *Tectonics, *Load distribution, Pressure distribution, Deformation, Open wells, Strain measurement, Geologic formations, Surface water, Vertical flow, Well capacity, Elastic properties, Porosity, Fluid flow, Compressibility, Hydraulic properties, Diffusivity, Materials testing.

The water level in an open well can change in response to deformation of the surrounding material, either because of applied strains (tidal or tectonic) or surface loading by atmospheric pressure changes. Under conditions of no vertical fluid flow and negligible well bore storage (static-confined conditions), the sensitivities to these effects depend on the elastic properties and porosity which characterize the surrounding medium. For a poroelastic medium, high sensitivity to applied areal strains occurs for low porosity, while high sensitivity to atmospheric loading occurs for high porosity; both increase with decreasing compressibility of the solid matrix. These material properties also influence vertical fluid flow induced by areally extensive deformation and can be used to define two types of hydraulic diffusivity which govern pressure diffusion, one for applied strain and one for surface loading. The hydraulic diffusivity which governs pressure diffusion in response to pressure loading is slightly smaller than that which governs fluid flow in response to applied strain. Given the static-confined response of a water well to atmospheric loading and earth tides, the in situ drained matrix compressibility and porosity (and hence the one-dimensional specific storage) can be estimated. Analysis of the static-confined response of five wells to atmospheric loading and earth tides gives generally reasonable estimates for material properties. (Author's abstract)
W90-02578

FREE THERMOHALINE CONVECTION IN SEDIMENTS SURROUNDING A SALT COLUMN.
Louisiana State Univ., Baton Rouge. Dept. of Geology and Geophysics.
D. G. Evans, and J. A. Nunn.
Journal of Geophysical Research (B) JJGBDU, Vol. 94, No. 9, p 12,413-12,422, September 10, 1989. 6 fig, 27 ref.

Descriptors: *Convection, *Saline water, *Salt domes, *Geohydrology, *Groundwater movement, *Solute transport, *Thermodynamics, Dimensional analysis, Heat transfer, Salts, Thermal conductivity, Numerical analysis, Simulation analysis, Homogeneity, Buoyancy, Algorithms, Isotherms, Boundary conditions, Fluid mechanics.

Complex groundwater convection patterns are possible near salt domes because groundwater is subject to both lateral heat and salinity gradients. In order to assess the mechanisms responsible for driving convection near salt domes, dimensional analysis and numerical simulations are used to investigate coupled heat and salt transport in homogeneous sediments surrounding a cylindrical salt dome. The coupled heat, solute, and groundwater transport equations are controlled by three dimensionless parameters: the Rayleigh number, the Lewis number, and the buoyancy ratio (the ratio of salinity to temperature effects on groundwater density, which directly affects the groundwater flow equation). A finite difference numerical multi-

gridding algorithm is used to iteratively solve the coupled transport equations. Boundary conditions for the numerical simulations were adjusted to represent different contrasts in the thermal gradient (parameterized by the thermal conductivity ratio) between the salt and the overlying sediments. The analysis suggests that a wide range of convective flow patterns are possible, with flow occurring either up or down along the salt flank. The sense of convection is dependent mainly on the value of the buoyancy ratio and how sharply isotherms are pulled up near the flank. These factors in turn depend on the regional salinity variation, the time since diapirism, and the thermal conductivity of water-saturated sediments. While this analysis provides useful insight into the mechanisms driving free convection near salt domes, the assumption about medium and fluid properties may limit the applicability of dimensional analysis in simulating flow in specific geologic settings. (Author's abstract)
W90-02579

HEAT FLOW DATA AND VERTICAL GROUNDWATER MOVEMENT, EXAMPLES FROM SOUTHWESTERN VIRGINIA.
New Mexico Inst. of Mining and Technology, Socorro.
M. Reiter, J. K. Costain, and J. Minier.
Journal of Geophysical Research (B) JJGBDU, Vol. 94, No. 9, p 12,423-12,431, September 10, 1989. 13 fig, 2 tab, 17 ref.

Descriptors: *Path of pollutants, *Landfills, *Convection, *Heat flow, *Waste disposal, *Groundwater movement, *Vertical flow, Subsurface water, Temperature effects, Temperature gradient, Flow discharge, Thermal conductivity, Graphical analysis, Convection, Fluid flow, Steady flow, Estimating equations, Virginia.

The direction of vertical groundwater flow has considerable practical importance at some locales, e.g., waste disposal sites. Because the subsurface temperature distribution is affected by groundwater flow, data from precision temperature logs can be used to estimate the vertical specific discharge. Estimates of the vertical specific discharge are often obtainable from plots of conducted heat flow versus temperature. Heat flow-temperature plots allow for variations in thermal conductivity across a zone of flow, whereas temperature gradient versus temperature plots assume constant conductivity. It is demonstrated, using examples from southwestern Virginia, that the two different plots can provide quite different estimates of vertical specific discharge. By considering vertically convected heat flow across a zone, better estimates of regional (geologically representative) heat flow can be made. Agreement between corrected heat flow values, conducted heat flows calculated near fluid flow exit boundaries, and regional values suggests that the steady state flow model used is reasonably representative, although the fluid flow depth interval is typically difficult to estimate confidently. The effects of small continuous well bore flow can be removed if continuity in the temperature log results; otherwise, it is most difficult to estimate specific discharge as confirmed by unrepresentative corrected heat flow data. (Author's abstract)
W90-02580

COMPOSITE ANALYTICAL MODEL FOR ANALYSIS OF PUMPING TESTS AFFECTED BY WELL BORE STORAGE AND FINITE THICKNESS SKIN.
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 7B.
W90-02583

MODELING THE TRANSPORT OF SOLUTES INFLUENCED BY MULTIPROCESS NONEQUILIBRIUM.
Florida Univ., Gainesville. Dept. of Soil Science.
M. L. Brusseau, R. E. Jessup, and P. S. C. Rao.
Water Resources Research WRERAQ, Vol. 25, No. 9, p 1971-1988, September 1989. 12 fig, 1 tab,

64 ref.

Descriptors: *Solute transport, *Model studies, *Groundwater movement, *Path of pollutants, *Groundwater pollution, *Sorption, Sensitivity analysis, Regression analysis, Mathematical studies, Aquifer systems, Soil water, Dimensional analysis, Equilibrium, Parametric hydrology.

The transport of solutes under nonequilibrium conditions in soil/groundwater systems is currently receiving a great deal of attention. Previously, it was often assumed that conditions of local equilibrium existed during solute transport under natural field conditions. Recent experimental and theoretical work has cast doubt on the validity of this assumption, however. The multiprocess nonequilibrium (MPNE) model explicitly accounts for multiple sources of nonequilibrium, and is specifically formulated for cases where nonequilibrium is caused by a combination of transport-related and sorption-related processes. Sensitivity analyses were performed to delineate the conditions under which the MPNE model reduces to the bicontinuum and to the local equilibrium models. These conditions are strongly controlled by the magnitude of the dimensionless rate parameters. Performance of the MPNE model was evaluated with several published data sets. An empirical regression equation was successfully used to estimate values for sorption rate constants required in the MPNE model. The MPNE model, with values for all parameters obtained from independent sources, predicted behavior exhibited by the data. This provides support for the validity of the conceptualization upon which the model is based. (Author's abstract)
W90-02586

FLOW CHANNELING IN A SINGLE FRACTURE AS A TWO-DIMENSIONAL STRONGLY HETEROGENEOUS PERMEABLE MEDIUM.
Lawrence Berkeley Lab., CA. Earth Sciences Div.
Y. W. Tsang, and C. F. Tsang.
Water Resources Research WRERAQ, Vol. 25, No. 9, p 2076-2080, September 1989. 4 fig, 1 tab, 16 ref.

Descriptors: *Geohydrology, *Path of pollutants, *Groundwater movement, *Geologic fractures, *Flow channels, *Heterogeneity, *Dimensional analysis, Tracers, Statistical methods, Fluid flow, Geohydrologic boundaries, Standard deviation, Distribution patterns, Anisotropy, Porosity, Permeability.

Recent interest in the evaluation of contaminant transport in bedrock aquifers and in the performance assessment of geologic nuclear waste repositories has motivated many studies of fluid flow and tracer transport in fractured rocks. The void space of a rock fracture can be conceptualized as a two-dimensional heterogeneous system with variable apertures as a function of position in the fracture plane. The apertures are generated using geostatistical methods. Fluid flow is simulated with constant head boundary conditions on two opposite sides of the two-dimensional flow region, with closed boundaries on the remaining two sides. The results show that the majority of flow tends to coalesce into certain preferred flow paths (channels) which offer the least resistance. Tracer transport is then simulated using a particle tracking method. The apertures along the paths taken by the tracer particles are found to obey a distribution with a larger mean and a smaller standard deviation. The shift in the distribution parameters increases with increasing values of variance for the apertures in the two-dimensional fracture. Provided that the correlation length is no greater than one-fifth of the scale of measurement, the aperture density distributions of tracer particle paths remain similar for flow in two orthogonal directions, even with correlation anisotropy ratio of up to 5. These results may be applicable in general to flow and transport through a two-dimensional strongly heterogeneous porous medium with a broad permeability distribution, where the dispersion of the system may be related to the parameters of the permeability distribution along preferred flow channels. (Author's abstract)
W90-02594

CASE STUDY AND PROPOSED DECONTAMINATION STEPS OF THE SOIL AND GROUNDWATER BENEATH A CLOSED HERBICIDE PLANT IN GERMANY.
Dekonta G.m.b.H., Mainz (Germany, F.R.).
For primary bibliographic entry see Field 5G.
W90-02616

APPLICATION OF AN INVERSE APPROACH TO A CANADIAN RADIOACTIVE WASTE DISPOSAL SITE.
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W90-02659

PHYSICALLY BASED DISTRIBUTION FUNCTION FOR LOW FLOW.
Oslo Univ. (Norway). Inst. of Geophysics.
For primary bibliographic entry see Field 2E.
W90-02762

DIFFERENCES BETWEEN THE ACTUAL AND NATURAL WATER QUALITY IN A SMALL DRAINAGE AREA WITH A HIGH LEVEL OF GROUNDWATER DISCHARGE.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
For primary bibliographic entry see Field 5B.
W90-02763

RISK-BASED SELECTION OF MONITORING WELLS FOR ASSESSING AGRICULTURAL CHEMICAL CONTAMINATION OF GROUND WATER.
For primary bibliographic entry see Field 7A.
W90-02765

NATIONAL EVALUATION OF THE LEACHING POTENTIAL OF ALDICARB, PART I: AN INTEGRATED ASSESSMENT METHODOLOGY.
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 5B.
W90-02766

PESTICIDES IN NEBRASKA'S GROUND WATER.
Nebraska Univ.-Lincoln. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W90-02767

CONTAMINATION OF THE SANDSTONE AQUIFER OF PRINCE EDWARD ISLAND, CANADA BY ALDICARB AND NITROGEN RESIDUES.
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W90-02768

GROUND WATER LOADING OF PESTICIDES IN THE ATLANTIC COASTAL PLAIN.
Maryland Univ., College Park. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W90-02769

AVAILABILITY AND CONTENT OF DOMESTIC WELL RECORDS IN THE UNITED STATES.
Research Triangle Inst., Research Triangle Park, NC. Center for Environmental Measurement.
For primary bibliographic entry see Field 7C.
W90-02770

ASSESSING ARKANSAS GROUND WATER FOR PESTICIDES: METHODOLOGY AND FINDINGS.
ENSECO, Inc., Boston, MA.
For primary bibliographic entry see Field 5A.
W90-02771

SMALL-SCALE RETROSPECTIVE GROUND WATER MONITORING STUDIES FOR AGRICULTURAL CHEMICALS: STUDY DESIGN AND SITE SELECTION.
Blasland, Bouck and Lee, Syosset, NY.
For primary bibliographic entry see Field 7A.
W90-02772

EPA'S APPROACH TO EVALUATING AND CLEANING UP GROUND WATER CONTAMINATION AT SUPERFUND SITES.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-02773

ANAEROBIC DECHLORINATION OF 2,4-DICHLOROPHENOL IN FRESHWATER SEDIMENTS IN THE PRESENCE OF SULFATE.
Georgia Univ., Athens. Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W90-02791

ANALYSIS OF TRICHLOROETHYLENE MOVEMENT IN GROUNDWATER AT CASTLE AIR FORCE BASE, CALIFORNIA.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 5B.
W90-02797

PERCHED BRINE PLUMES ABOVE SALT DOMES AND DEWATERING OF GEOPRESSURED SEDIMENTS.
Indiana Univ., Bloomington. Dept. of Geology.
V. Ranganathan, and J. J. Hanor.
Journal of Hydrology JHYDA7, Vol. 110, No. 1/2, p 63-86, Sep 1989. 15 fig, 1 tab, 48 ref.

Descriptors: *Geochemistry, *Geohydrology, *Salt domes, *Louisiana, *Brines, *Geologic fractures, Brine plumes, Model studies, Groundwater movement, Permeability, Geopressure.

Previous studies have shown that there is a brine plume with more than 160 g/L total dissolved solids (TDS) in the subsurface, perched above Welsh Salt Dome in South Louisiana. The occurrence of this plume has been postulated to be due to the expulsion of geopressured fluids up a fault on the flank of Welsh Dome. The process that resulted in formation of the anomalous brine plume near Welsh Dome is of importance because hydrocarbon production is approximately coincident with the brine plume in map plan, although in cross-sections, the brine plume actually occurs a few hundred meters above hydrocarbon production zones. Using a variable density groundwater flow model, SUTRA, the hypothesis that a pulse of fluid flow up the fault could result in brine formation near the top of the dome was tested. When the permeability of the geopressured zone was very low in the simulations, brine formation in the hydropressured zone occurred entirely by brine-density flow and flow was downward along the fault flanking the dome. Above a certain threshold permeability for the geopressured zone, between 10 to the minus 7th power darcy and 0.00001 darcy in the vertical direction, geopressured fluids were forced up the fault and brine formation occurred above the dome rather than on the flank. Brines can theoretically form above salt domes in very short geologic times (0.1 Ma) by expulsion of waters from the geopressured zone below, but the fluid effluxes required are gigantic and appear to be unsustainable over large time intervals such as 10 Ma. (Author's abstract)
W90-02799

RADIOTRACER DISPERSION TESTS IN A FISSURED AQUIFER.
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Civil Engineering.
D. Stephenson, W. A. J. Paling, and A. S. M. De Jesus.
Journal of Hydrology JHYDA7, Vol. 110, No. 1/2, p 153-164, Sep 1989. 6 fig, 3 tab, 9 ref.

Descriptors: *Groundwater movement, *Tracers, *Saline water intrusion, *Aquifers, *Radioactive tracers, *Geohydrology, *Coastal aquifers, Mathematical models, Saline water intrusion, Pump testing.

Coastal sites were investigated for possible construction of a power station; aquifer geohydrological parameters were established on a macro scale for the purpose of estimating sea water intrusion and interface mixing; and laboratory tests, pump tests and packer tests were conducted to make successively better estimates of the aquifer properties. Site tests were then conducted to determine dispersivities. The holes were in groups of five, with a central injection hole and four surrounding holes on generally north-south and east-west axes at distances ranging from 3 to 16m from the central hole. The radiotracer was selected after conducting laboratory adsorption tests. Injections of 51Cr were made, followed by continuous pumping of water into the central hole. Radiotracer concentrations were determined by inserting a probe in the surrounding holes at intervals over the depth of the hole. The concentrations were corrected for background and decay and plotted against time. A mathematical model of the process was calibrated to yield the aquifer dispersivities at different depths. The values were found to be depth and direction dependent. Aquifer characteristics in saturated zones, i.e. transmissivity and dispersivity, can be quite effectively determined in situ by means of artificial tracers, provided the behavior of such tracers is representative of that of the water in the aquifer, and the scale of the field experiment is comparable with the largest expected fissures and channels in the formations. Because radioisotopic tracers can be detected at extremely low concentrations, they have been increasingly used in this type of study. (Author's abstract)
W90-02803

DISCRETIZATION AND COST-EFFECTIVENESS OF A FINITE ELEMENT SOLUTION FOR HILLSLOPE SUBSURFACE FLOW.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2E.
W90-02804

WATER FLOW IN A HUMMOCKY LANDSCAPE IN CENTRAL SASKATCHEWAN, CANADA, II. SATURATED FLOW AND GROUNDWATER RECHARGE.
Saskatchewan Univ., Saskatoon. Saskatchewan Inst. of Pedology.
B. J. Zebarth, E. De Jong, and J. L. Henry.
Journal of Hydrology JHYDA7, Vol. 110, No. 1/2, p 181-198, Sep 1989. 7 fig, 2 tab, 27 ref.

Descriptors: *Groundwater recharge, *Canada, *Groundwater movement, Saskatchewan, Precipitation, Hydraulic conductivity, Marshes, Conductivity.

Relatively few estimates of the rate of groundwater recharge have been obtained in the Interior Plains region of North America. The purpose of this study was to characterize the saturated flow system surrounding two sloughs in a hummocky upland area in central Saskatchewan and to estimate the groundwater recharge rate. The saturated flow system was dominated by two factors. First, deposits at the soil surface had a high hydraulic conductivity which resulted in rapid horizontal flow at shallow depth at the edge of the sloughs. Second, a low hydraulic conductivity layer at approximately 12m depth impeded the rate of vertical flow. The annual fluctuation of the water table in the sloughs was in the order of 2m, but this fluctuation was buffered by a 10m deep saturated zone over the impeding layer, and the system approximated steady state flow. The groundwater recharge rates for the sloughs ranged from 250 to 300mm/yr. Accumulation of soluble salts, as indicated by electrical conductivity, and high soluble $Mg(2+)/Ca(2+)$ ratios above 5m depth in the midslope and knoll positions indicated that minimal groundwater recharge had occurred in the past. A regional recharge rate of approximately 35mm/yr or 10% of the annual precipitation was calculated based on the recharge rate and areal extent of sloughs. (Author's abstract)

W90-02805

WATER FLOW IN A HUMMOCKY LANDSCAPE IN CENTRAL SASKATCHEWAN, CANADA, III. UNSATURATED FLOW IN RELATION TO TOPOGRAPHY AND LAND USE.
Saskatchewan Univ., Saskatoon. Saskatchewan Inst. of Pedology.
B. J. Zebarth, and E. De Jong.
Journal of Hydrology JHYDA7, Vol. 110, No. 1/2, p 199-218, Sep 1989. 6 fig, 6 tab, 36 ref.

Descriptors: *Groundwater recharge, *Canada, *Soil water, *Land use, Topography, Tensiometers, Neutron access tubes, Slope, Marshes, Depth, Agriculture, Saskatchewan.

The importance of unsaturated flow in groundwater recharge and soil development in the Interior Plains region of North America is poorly understood. The purpose of this study was to obtain quantitative estimates of unsaturated water flow rates in a hummocky upland area and to relate the flow rates to topography and land use. The sites consisted of closed drainage basins, 80-150m across, surrounding individual temporary sloughs in the Black soil zone in central Saskatchewan and were instrumented with tensiometers and neutron access tubes. The sites were divided into lower slope, upper slope and saddle positions on the basis of landscape surface form. The magnitude of the unsaturated flux was commonly 10 to the minus 8th power m/s in the lower slope positions, 10 to the minus 9th power to 10 to the minus 8th power m/s in the saddle positions, 10 to the minus 10th power to 10 to the minus 9th power m/s in the upper slope positions following summer-fallowing and 10 to the minus 10th power m/s or less in the upper slope positions following three consecutive years of cropping. Downward flow was of similar magnitude to upward flow in the lower slope positions and two-fold to five-fold higher than upward flow in the upper slope and saddle positions. In a year with 30% above average rainfall, up to 25mm of downward flow and 5mm upward flow occurred across the bottom of the root zone in the saddle positions. The unsaturated downward flux penetrated to greater than 2.5m depth and was sufficiently large to be of importance to soil development and crop growth. Deep drainage was greater in saddle than in upper slope positions, greater following summer-fallow than following three years of cropping, and least under native vegetation. (Author's abstract)
W90-02806

GROUND-WATER LEVEL DATA FOR NORTH CAROLINA--1987.
Geological Survey, Raleigh, NC. Water Resources Div.
R. W. Coble, A. G. Strickland, and M. C. Bailey.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-68, July 1989. 152p, 71 fig, 3 tab, 70 ref.

Descriptors: *Groundwater level, *Water resources data, *Data collections, *Groundwater storage, *North Carolina, *Virginia, *Observation wells, *Aquifers, Potentiometric level, Physiographic provinces, Network design, Groundwater recharge.

Continuous and periodic measurements in 54 key wells and water-level measurements emplaced in Coastal Plain aquifers across North Carolina in 193 supplemental wells are presented in this report. Hydrographs of selected wells show changes in groundwater storage in the State. The water table in the shallow aquifers was higher throughout most of the State in 1987 than in 1986, indicating that rain had recharged these aquifers sufficiently to replenish the deficit in groundwater storage that accumulated in the western and central parts of the State during 1986. Water levels in the heavily pumped Coastal Plain aquifers show a general downward trend for the year, indicating groundwater is being withdrawn from aquifer storage. Record low water levels were measured in 4 of 13 wells in the Castle Hayne aquifer; the greatest decline measured during 1987 was 0.3 ft. Water

levels in wells in the Peedee, Black Creek, upper Cape Fear, and lower Cape Fear aquifers generally show downward trends. Record low water levels were measured in 4 of 8 wells in the Peedee aquifer; the maximum decline measured during 1987 was 1.5 ft. All wells in the Black Creek, upper Cape Fear, and lower Cape Fear aquifers had record low water levels for 1987, with maximum measured declines in 1987 of 8.6, 3.1, and 3.1 ft., respectively. Record high water levels were measured in two wells, one each in the Castle Hayne and Peedee aquifers. Potentiometric surface maps show the effects of major centers of pumping for the Castle Hayne, Black Creek, and lower Cape Fear aquifers of the Coastal Plain. (USGS)
W90-02846

WATER RESOURCES AND EFFECTS OF POTENTIAL SURFACE COAL MINING ON DISSOLVED SOLIDS IN HANGING WOMAN CREEK BASIN, SOUTHEASTERN MONTANA.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 4C.
W90-02848

WATER QUALITY AND SUPPLY, CORTINA RANCHERIA, COLUSA COUNTY, CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
E. B. Yates.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4004, June 1989. 28p, 9 fig, 3 tab, 26 ref.

Descriptors: *California, *Geophysical surveys, *Water resources data, *Groundwater, *Geohydrology, *Hydrologic data, Colusa County, Electromagnetic terrain conductivity survey, Surface water, Rainfall-runoff relationships, Water quality, Water supply.

Cortina Rancheria covers an area of 1 sq mi in Colusa County, California, near the western edge of the Sacramento Valley. Local sources of water for residents of the rancheria are of poor quality or limited availability. Domestic needs are presently met by water from a hand-dug well and from a drilled well with a potential yield of 15 gal/min. Water from both wells fails to meet California State drinking-water standards, primarily because of high concentrations of chloride and dissolved solids. High concentrations of sodium and boron pose additional problems for agricultural use of the water. The dissolved ions originate in Upper Cretaceous marine sediments of the Cortina Formation, which occurs at or near land surface throughout the rancheria. Small quantities of fresh groundwater may occur locally in the Tehama Formation which overlies the Cortina Formation in the eastern part of the rancheria. Canyon Creek, the largest stream on the rancheria, flows only during winter and spring. Water from one of the rancheria's three springs meet drinking water standards, but it almost stops flowing in summer. The generally poor quality of ground and surface water on the rancheria is typical of areas along the west side of the Sacramento Valley. Additional hydrologic information could indicate more precisely the quantity and quality of surface and groundwater on Cortina Rancheria. Principal features of a possible data-collection program would include monitoring of discharge and water quality in three springs and in Canyon Creek, electromagnetic terrain conductivity surveys, and monitoring of water levels and quality in two existing wells and several proposed test wells. (USGS)
W90-02850

PRECIPITATION, STREAMFLOW, AND BASEFLOW IN WEST-CENTRAL TEXAS, DECEMBER 1974 THROUGH MARCH 1977.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-02851

DESCRIPTION OF DATA FILES COMPILED FOR THE CENTRAL MIDWEST REGIONAL AQUIFER-SYSTEM ANALYSIS.
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 7B.
W90-02852

ANALYTICAL SOLUTIONS FOR ONE-, TWO-, AND THREE-DIMENSIONAL SOLUTE TRANSPORT IN GROUND-WATER SYSTEMS WITH UNIFORM FLOW.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-02855

CHLORINATED ORGANIC COMPOUNDS IN GROUNDWATER AT ROOSEVELT FIELD, NASSAU COUNTY, LONG ISLAND, NEW YORK.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-02859

ESTIMATION OF HYDRAULIC CHARACTERISTICS OF THE UPPER GLACIAL AND MAGOTHY AQUIFERS AT EAST MEADOW, NEW YORK, BY USE OF AQUIFER TESTS.
Geological Survey, Albany, NY. Water Resources Div.
K. R. Prince, and B. J. Schneider.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4211, 1989. 43p, 14 fig, 6 tab, 18 ref, append.

Descriptors: *Aquifer characteristics, *Aquifer testing, *Long Island, *New York, *Pumping tests, *Geohydrology, Computer models, Groundwater, Drawdown, Water yield, Groundwater movement.

Drawdown and recovery data from two aquifer tests in central Nassau County, NY were used to calculate aquifer characteristics by several methods to aid in predicting the response of the aquifer system to stress. The first test, on May 12, 1978, entailed pumping the Magothy aquifer for 12 hours; the second on July 30-31, 1985, entailed pumping the upper glacial aquifer for 24 hours. Drawdown and recovery data from both tests were analyzed through analytical solutions and curve-matching procedures, and the resulting hydraulic values were used as initial values in a finite-element radial-flow numerical model to simulate the observed drawdowns and recoveries. Storativity values obtained by all methods were consistent with published estimates; but hydraulic conductivity values were higher than published estimates. The simple analytical solutions and curve-matching procedures gave reasonable values of most terms quickly, but the greatest confidence is in the estimates made with the finite-element model. These estimates for the Magothy aquifer were: horizontal hydraulic conductivity of 100 ft/d; ratio of horizontal to vertical conductivity, 5; and specific storage, 0.0001. Estimates for the upper glacial aquifer were: horizontal hydraulic conductivity, 380 ft/d; ratio of horizontal to vertical hydraulic conductivity, 2.5; and specific yield, 0.15. (USGS)
W90-02860

HYDROGEOLOGIC CORRELATIONS FOR SELECTED WELLS ON LONG ISLAND, NEW YORK--A DATABASE WITH RETRIEVAL PROGRAM.
Geological Survey, Albany, NY. Water Resources Div.
H. T. Buxton, D. A. Smolensky, and P. K. Shernoff.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 86-4318, 1989. 107p, 4 fig, 2 tab, 8 ref.

Descriptors: *Water resources data, *Geohydrology, *Areal hydrogeology, *Long Island, *New York, *Data collections, *Databases, Data storage and retrieval, Water yield, Aquifers.

Accurate delineation of the internal hydrogeologic structure of Long Island, NY is integral to the understanding and management of the groundwater system. This report presents a computerized data base of hydrogeologic correlations for 3,146 wells on Long Island and adjacent parts of New York City. The data base includes the well identification number, the latitude-longitude of the well location, the altitude of land surface at the well and of the bottom of the drilled hole, and the altitude of the top of the major hydrogeologic units penetrated by the well. A computer program is included that allows retrieval of selected types of data for all of, or any local area of, Long Island. These data retrievals are a valuable aid to the construction of hydrogeologic surface maps. (USGS)
W90-02862

HYDROGEOLOGY OF THE SOUTHWESTERN PART OF THE TOWN OF HEMPSTEAD, NASSAU COUNTY, NEW YORK.
Geological Survey, Albany, NY. Water Resources Div.
R. K. Krulikas.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 85-4288, 1989. 16p, 3 fig, 3 tab, 21 ref.

Descriptors: *Geohydrology, *New York, *Groundwater resources, Geologic units, Groundwater level, Subsurface mapping.

The groundwater resources of the southwestern part of the Town of Hempstead in Nassau County, NY were investigated in 1984. The area studied encompasses 85 sq mi, or 68% of the town's 125-sq mi area. The groundwater reservoir underlying the area consists of unconsolidated gravel, sand, silt, and clay of Holocene, Pleistocene, and Late Cretaceous age that have been divided into eight geologic units. The maximum total thickness of the unconsolidated deposits is about 1,500 ft. Precipitation is the sole source of groundwater recharge in the area. The average annual precipitation, as recorded at Valley Stream during 1927-83, was 42.62 in. The water table altitude in the 1980's has recovered and equalled or exceeded that before the regional drought of 1962-66. The potentiometric surfaces in the Magothy and Lloyd aquifers are still somewhat below those before the drought but are recovering throughout most of the area. The report presents 10 maps showing the surface altitude of the geologic units as well as the potentiometric altitudes of the three major aquifers. Also included are six geologic sections, four hydrographs, and several graphs presenting the data that was collected. (USGS)
W90-02863

HYDROGEOLOGY.
Geological Society of North America, Boulder, Colorado. 1988. The Geology of North America: Vol. O-2. Edited by William Back, Joseph S. Rosenshein and Paul R. Seaber. 542p.

Descriptors: *Aquifer characteristics, *North America, *Groundwater movement, *Geohydrology, *Geohydrologic units, Geohydrologic boundaries, Physiographic provinces, Geologic units, Aquifer systems, Geomorphology, Stratigraphy, Structural geology, Geologic history, Research priorities, Comparison studies.

A collective effort of members of the Hydrogeology Division of the Geological Society of America was compiled in one volume to address the relation of groundwater to geology. A synthesis of current hydrogeologic understanding is merged with principles and processes from other sub-disciplines of geology to demonstrate hydrogeologic principles, concepts, and processes that control the occurrence, movement, storage, and chemical character of groundwater. One goal of this publication is to identify, clarify, and describe systematically the basic relation of hydrogeology to other sub-disciplines such as geomorphology, stratigraphy, structure, and historical geology; one prime purpose is communication and stimulation of geologically-oriented research, creative exploration and management of groundwater resources, and advances in knowledge of regional and comparative hydrogeology in North America. The first section introduces an historical perspective and terminology of hydrostratigraphic units; the second section is composed of a series of articles, each dedicated to one of 28 specific hydrogeologic regions described in North America; the third section dedicates each article to an aspect of comparative hydrology (characteristics of specific geologic classifications); the fourth section contains eight articles describing different groundwater and geologic processes; the fifth and final section presents a brief outline for the future. (See W90-02867 thru W90-02914) (Fish-PTT)
W90-02866

HISTORICAL PERSPECTIVE.
Geological Survey, Reston, VA.
G. Meyer, G. Davis, and P. E. LaMoreaux.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 1-8. 3 fig, 65 ref.

Descriptors: *Geohydrology, *Geology, *Hydrology, *Groundwater movement, *Aquifer systems, *Water chemistry, Aquifers, Groundwater potential, Irrigation, Engineering geology, Interagency cooperation, Governmental interrelations, Chemical properties, Hydrodynamics, Mineralogy, Isotopic tracers, Groundwater, Mass transfer, Oxidation-reduction potential, Canada, Mexico, North America.

Modern hydrogeology is based upon evolution of concepts, principles, and knowledge of physical basic processes. Hydrogeology is a young science, an offspring of geology and hydrology, identified for the most part only during the past 100 years. Early North American hydrogeology arose with pragmatic groundwater exploration mainly for irrigation water supply in the western United States. Investigations in the populated areas of the East focused on the engineering aspects of localized water development. Cooperation among local, state, and federal water agencies in the United States, and among equivalent jurisdictions in Canada and Mexico, accelerated description of the groundwater systems of the continent. Chemical hydrogeology is a younger arm of the groundwater science, arising in the twentieth century after the basic geologic and hydrodynamic elements were in place. Primary chemical reactions and their controls on the chemical nature of groundwater, the concept of mineral equilibria, and oxidation-reduction reactions were identified by the 1950s. By the end of the decade, the important role of mass balance, mass transfer, mineral equilibria, and kinetics in groundwater chemical systems were identified and in use. With the advent of the nuclear age, hydrogeologists developed the use of environmental isotopes for investigating the occurrence and movement of groundwater. Methods of investigation and problem-solving developed along with the science; the origins of modern methods of regional hydrogeologic investigation are an important element of the growth of hydrogeology. (See also W90-02866) (Fish-PTT)
W90-02867

HYDROSTRATIGRAPHIC UNITS.
Illinois State Geological Survey Div., Champaign.
P. R. Seaber.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 9-14. 38 ref.

Descriptors: *Hydrostratigraphy, *Aquifer systems, *Stratigraphy, *Classification, *Geohydrology, *Geohydrologic units, *Geologic units, Geologic mapping, Hydrologic maps, Geohydrologic boundaries, Groundwater.

The scientific classification and nomenclature of hydrostratigraphic units closely parallels that of other rock units. Presently, there are no available categories in any major codes of stratigraphic nomenclature that can adequately accommodate hy-

drostratigraphic units. The question remains open with many hydrogeologists as to whether interstices need to be a formally recognized mappable criterion, and more important, whether hydrostratigraphic mapping criteria and nomenclature can or need be included in the North American Stratigraphic Code or in the revised International Stratigraphic Guide. Hydrogeologic terminology is presently not uniform or consistent. Any terminology set forth should be applicable to all earth materials and all disciplines. This would assure consistent and uniform usage in classification, mapping, and terminology of hydrostratigraphic units, at least among geologists and hydrogeologists. (See also W90-02866) (Fish-PTT)
W90-02868

HYDROGEOLOGIC SETTING OF REGIONS.
Geological Survey, Raleigh, NC.
R. C. Heath.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 15-23. 3 fig, 2 tab, 5 ref.

Descriptors: *Geohydrology, *Geohydrologic units, *Groundwater, *Aquifer systems, *North America, Aquifer characteristics, Rock properties, Water-carrying capacity, Structural geology, Soil porosity, Mineralogy, Solubility, Hydraulic properties.

Groundwater occurs in the openings in the rocks that form the North American continent. It is useful in hydrogeology to classify openings in rocks on the basis of origin. The major rock units of the groundwater system can be differentiated primarily on the basis of their water-bearing characteristics--that is, on the nature and other aspects of their openings. An important factor, in addition to geologic structure and texture, that affects the volume and hydraulic characteristics of openings is mineral composition, primarily of importance because of its effect on rock solubility. For the purpose of delineating the groundwater regions, geologic features need to be restated in terms of hydrogeologic features. North America is divided into 28 groundwater regions. A brief description with specific hydrogeological situations and ranges in the hydraulic characteristics of the dominant aquifers is tabulated for each of the 28 regions. (See also W90-02866) (Fish-PTT)
W90-02869

REGION 1, WESTERN MOUNTAIN RANGES.
Geological Survey, East Wenatchee, WA.
B. L. Foxworthy, D. L. Hanneman, D. L. Coffin, and E. C. Halstead.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 25-35. 2 fig, 1 tab, 29 ref.

Descriptors: *Western Mountain Ranges, *North America, *Geohydrology, *Groundwater, *Mountains, Elevation, Altitude, Geologic control, Topography, Slopes, Physiographic provinces, Metamorphic rocks, Igneous rocks, Sedimentary rocks, Geologic fractures, Groundwater reservoirs, Valleys, Climates, Groundwater potential, Population density, Water quality.

The Western Mountain Ranges region owing to its areal extent and large range in altitude and latitude, includes perhaps the greatest diversity of geologic conditions and processes of all the regions of North America. Consequently, groundwater conditions also are highly varied. The region includes 15 subregions: 12 are mountainous and three are intermontane and lowland subregions. Although the regional boundaries are based mainly on topographic breaks in slope, at places they represent compromises between lithologic and physiographic boundaries. Geologic conditions and processes, in the broadest sense, control virtually all aspects of the occurrence of groundwater in the region. The Western Mountain Ranges region consists largely of consolidated igneous, metamorphic, and sedimentary rocks. Virtually the entire region has been subjected to intense folding and faulting. The most accessible productive groundwater reservoirs in the region are unconsolidated clastic deposits that underlie floors of valleys and other

lowlands. The most obvious effect of the climate (ranging from semiarid to very wet) on groundwater is the availability of recharge. These climatic conditions may be grouped as three different mountain zones: upper, middle, and lower. In general, the pattern of groundwater development and use closely reflects the population distribution. Most reported problems involve deteriorating water quality. (See also W90-02866) (Fish-PTT)
W90-02870

REGION 2, COLUMBIA LAVA PLATEAU.
Geological Survey, Boise, ID.
G. F. Lindholm, and J. J. Vaccaro.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 37-50. 5 fig, 1 tab, 40 ref.

Descriptors: *Groundwater movement, *Lava flows, *Columbia Lava Plateau, *Geohydrology, *Geohydrologic units, Geologic units, Geohydrologic boundaries, Hydraulic conductivity, Transmissivity, Storage coefficient, Geochemistry, Climates, Well yield, Arid climates, Semiarid climates, Basalts, Rhyolites, Sedimentary rocks, Water quality, California, Washington, Oregon, Idaho, Nevada.

The Columbia Lava Plateau in northern California, eastern Washington and Oregon, southern Idaho, and northern Nevada is drained by the Columbia River and its tributaries. Much of the Columbia Lava Plateau has an arid to semiarid climate. Two major basalt units, the Columbia River Basalt Group and the Snake River Group, crop out or are at shallow depth in nearly half of the Columbia Lava Plateau. Various basaltic, rhyolitic, and sedimentary rock units underlie the remainder of the plateau. Volcanic rocks, particularly basalt, store and yield large quantities of good-quality water. The geologic, hydrogeologic (hydraulic conductivity, transmissivity, storage coefficient, and well yield), and geochemical properties of major rock units underlying the Columbia Lava Plateau have been summarized. (See also W90-02866) (Fish-PTT)
W90-02871

REGION 3, COLORADO PLATEAU AND WYOMING BASIN.
Wright Water Engineers, Inc., Denver, CO.
O. J. Taylor, and J. W. Hood.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 51-58. 7 fig, 15 ref.

Descriptors: *Colorado Plateau, *Aquifers, *Geohydrology, *Hydrologic systems, *Geologic units, Climates, Geohydrologic boundaries, Sedimentary rocks, Paleozoic era, Mesozoic era, Cenozoic era, Limestone, Dolomite, Sandstones, Shales, Confining beds, Aquicludes, Groundwater movement, Geologic control, Erosion, Tectonics, Basins, Groundwater recharge, Colorado, Wyoming, Utah, New Mexico, Arizona.

The Colorado Plateau and Wyoming Basin include parts of Wyoming, Utah, Colorado, New Mexico, and Arizona. Rock types and their hydrologic characteristics are diverse. Consolidated sedimentary rocks of Paleozoic, Mesozoic, and Cenozoic age attain a maximum thickness of more than 6,000 meters. Limestone, dolomite, sandstone, and shale beds include major aquifers in some areas; limestone, dolomite, shale, and evaporite deposits are common confining layers. Broad features of most groundwater flow systems are controlled by geologic structure, climate, and erosion. Repeated tectonic activity has deformed the region into numerous basins and uplifts. Because of these structures, aquifers that are stratigraphically low in the geologic section and at great depth in basins are exposed in or near uplifted areas. Exposed aquifers are recharged by snow and rain in mountainous uplifted areas. (See also W90-02866) (Fish-PTT)
W90-02872

REGION 4, CENTRAL VALLEY AND PACIFIC COAST RANGES.
Geological Survey, Santa Rosa, CA.

C. D. Farrar, and G. L. Bertoldi.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 59-67. 4 fig, 28 ref.

Descriptors: *Central Valley, *Coast Ranges, *Geohydrology, *Geohydrologic units, *California, *Groundwater basins, *Hydrologic systems, Geohydrologic boundaries, Hydraulic conductivity, Geologic time, Geologic control, Deformation, Geologic history, Hydraulic properties, Alluvium, Valleys, Mountains, Fracture permeability, Available water, Sediments, Aquifer characteristics, Subsidence.

The Central Valley and Coast Ranges of California include two distinctly different geologically and hydrologically separated subregions, evolved geologically from the same large-scale processes acting on the continental margin of western North America during middle Mesozoic through Cenozoic time. Deformation during Cenozoic time has been minimal in the Central Valley relative to that in the Coast Ranges. The Central Valley is virtually one large groundwater basin with hydraulic continuity throughout. In contrast, extensive post-Jurassic faulting in the Coast Ranges has broken the subregion into numerous small alluvium-filled valleys hydrologically separate from one another. Groundwater in the mountainous parts of the Coast Ranges is contained primarily in fractured rocks, and the availability of water is greatly restricted; areally extensive, productive aquifers are found within the sedimentary fill of the larger valleys. Groundwater withdrawal from Central Valley aquifers has been the cause of extensive land subsidence. Adverse impacts caused by groundwater withdrawals are controlled by lithology and geologic structures within the region. (See also W90-02866) (Fish-PTT)
W90-02873

REGION 5, GREAT BASIN.
Mifflin and Associates, Inc., Las Vegas, NV.
M. D. Mifflin.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 69-78. 8 fig, 20 ref.

Descriptors: *Great Basin, *Groundwater movement, *Geohydrology, *Geohydrologic units, Geologic units, Geohydrologic boundaries, Hydrography, Basins, Arid climates, Mountains, Geologic control, Altitude, Rainfall impact, Geologic fractures, Air circulation, Surface drainage, Paleohydrology, Groundwater recharge, Discharge capacity, Carbonate rocks.

The Great Basin is a hydrographically defined region of the southwestern United States. Its hydrogeology is unique owing to a combination of basin-and-range structure, arid climates, and interior drainage. A repetitious pattern of north-trending mountain ranges and intermontane structural basins establishes the geologic control of the region. Climates are generally a function of altitude and, to a lesser extent, latitude and rain shadow effects. The dominant factors in creating the special hydrogeologic conditions common to the region are: extensional faulting, regional patterns of atmospheric circulation, surface drainage, and paleohydrology. Marked variations can be seen in sizes of the groundwater flow systems, and the relative distances between recharge areas and the terminal discharge areas within multitudes of arid bolsons. Areas with interbasin-flow configurations are the most common in the carbonate rock province. (See also W90-02866) (Fish-PTT)
W90-02874

REGION 6, COASTAL ALLUVIAL BASINS.
W. F. Hardt.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 79-80. 1 fig, 1 ref.

Descriptors: *Coastal Alluvial Basins, *Alluvial aquifers, *Geohydrology, *Geohydrologic units, *Groundwater movement, *California, *Mexico, Geologic units, Geohydrologic boundaries, Igne-

ous rocks, Sedimentary rocks, Metamorphic rocks, Geologic fractures, Mountains, Alluvial deposits, Geologic time, Climates, Topography, Groundwater barriers, Pumping.

The coastal basins of southern California and adjacent parts of Mexico are characteristics by irregularly-shaped mountains adjacent to and surrounding sediment-filled basins. The geology of this region is exceedingly complex, compounded by the presence of many fault systems. Hydrologically, the area is less complex, with most of the groundwater occurring in alluvial basins of Pliocene, Pleistocene, and Holocene age. The mountains consist of consolidated sediments and igneous, metasedimentary, and metavolcanic rocks. Comparatively little groundwater occurs in these rocks. Topography is an important factor in controlling the presence and movement of groundwater. Faults in the alluvial basins act as barriers to groundwater movement and can have major effects on pumping patterns in highly developed basins, whereas faults in the mountains have less hydrologic influence. (See also W90-02866) (Fish-PTT)
W90-02875

REGION 7, CENTRAL ALLUVIAL BASINS.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 2A.
W90-02876

REGION 8, SIERRA MADRE OCCIDENTAL.
Comision Federal de Electricidad, Mexico City.
For primary bibliographic entry see Field 2A.
W90-02877

REGION 9, SIERRA MADRE ORIENTAL.
J. M. Lesser, and G. Lesser.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 89-92. 4 fig, 3 ref.

Descriptors: *Sierra Madre Oriental, *Groundwater movement, *Mexico, *Geohydrology, *Geohydrologic units, Geologic units, Geologic control, Structural geology, Carbonate rocks, Sinks, Mesozoic era, Coastal plains, Precambrian era, Arid climates, Semiarid climates, Humid climates, Limestone, Permeability, Porosity, Flow discharge, Confined aquifers, Sediments, Potable water, Alluvial aquifers, Rainfall infiltration.

The infiltration, circulation, and occurrence of groundwater in the Sierra Madre Oriental in Mexico is directly influenced by the lithology and structure of the rocks. This region is composed primarily of a series of folded calcareous rocks of Mesozoic age that have a general northwest to southeast orientation. The region is characterized by arid and semiarid zones, except in its eastern portion; there it joins with the Gulf Coastal Plain, and the climate is transitional to humid tropical. The region is divided into three subregions, the north, central, and south, respectively, which are designated: Sierra del Burro, Cuenca de Ojinaga-Monclova-La Paila Basin, and Sierra Torreon-Monterrey-Tamazunchale. The Sierra del Burro subregion is an extensive uplift of limestones containing five different hydrologic zones, differentiated on the basis of geochemistry, containing confined aquifers. The Cuenca Ojinaga-La Paila subregion is underlain by calcareous rocks folded into a series of anticlines that form sierras, with two types of aquifers (those in sedimentary fill and those in limestones). Potable water occurs in the shallow limestones. A series of continuous folds in carbonate rocks have formed the Sierra Madre Oriental chain, containing spectacular canyons with vertical walls exposing outcrops of rocks ranging in age from Precambrian to Quaternary. Alluvial materials form aquifers in the Torreon subregion; the steeply-dipping flanks of exposed anticlines provides rainfall infiltration in the highly porous bedding of the Monterrey subregion; highly permeable carbonates provide numerous sinkholes, lateral flow and spring discharges in the Tamazunchale subregion. (See also W90-02866) (Fish-PTT)
W90-02878

REGION 10, FAJA VOLCANICA TRANSMEXICANO.
Secretaria de Agricultura y Recursos Hidraulicos, Mexico City. Subdireccion Geohidrologia.
For primary bibliographic entry see Field 2A.
W90-02879

REGION 11, SIERRA MADRE DEL SUR.
R. R. Palacio.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 99-100. 1 fig.

Descriptors: *Geohydrology, *Geohydrologic units, *Karst hydrology, *Groundwater movement, *Sierra Madre del Sur, Geologic units, Geologic control, Mountains, Metamorphic rocks, Geologic time, Paleozoic era, Rainfall, Permeability, Dolomite, Sand, Shales, Silt, North America, Water resources development, Surface water, Reservoir storage, Drainage area, Subsurface water, Runoff, Tectonics, Mexico.

The Sierra Madre del Sur is a mountainous chain in southern Mexico composed primarily of a basement of metamorphic rocks that were displaced during Jurassic time and a batholith that constitutes the Oaxaca Massif and the Sierra Madre de Chiapas. This area also is underlain by other impermeable formations composed of dolomite, recrystallized limestone, and red beds composed of shale, sand, and silt of Paleozoic, Triassic, and Jurassic age. This region has the greatest rainfall in North America. Groundwater resources are quite limited in this province, but the sites for surface water impoundments and reservoirs are numerous. The drainage area of this mountainous region is quite complex because of the wide range in permeability of the rocks and the numerous tectonic structures. All of the water eventually drains into the major rivers, either as overland runoff or subsurface flow. The Pacific coastal Plain is a narrow strip, 10 to 25 miles wide, parallel to both the mountains and the Pacific Ocean. The Gulf Coastal Plain is a swampy area composed of fine-grained sediments with low potential for groundwater occurrence. The mountains are formed primarily by Cretaceous limestone and dolomite, which are highly karstified. Commonly the streams are lost into limestone cavities and reappear as springs that form magnificent waterfalls down the ridges. Groundwater is produced only in the recharge areas because the excessive subsurface drainage in other areas causes the water table to be extremely deep. (See also W90-02866) (Fish-PTT)
W90-02880

REGION 12, PRECAMBRIAN SHIELD.
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
R. N. Farvolden, O. Pfannkuch, R. Pearson, and P. Fritz.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 101-114. 10 fig, 64 ref.

Descriptors: *Precambrian Shield Region, *North America, *Groundwater movement, *Geohydrology, *Geohydrologic units, *Precambrian era, Geologic control, Geohydrologic boundaries, Geochemistry, Humid climates, Petrology, Physiographic provinces, Structural geology, Metamorphic rocks, Igneous rocks, Sedimentary rocks, Fracture permeability, Surface water, Water quality, Lakes, Canada.

The Precambrian Shield represents the largest petrologically homogeneous and contiguous province of the North American continent. Crystalline metamorphic rocks underlie most of the Shield, and structural provinces are defined on the basis of age, lithology, and structural features. In places, relatively unmetamorphosed igneous rocks or indurated sedimentary rocks are predominant, but all have more or less the same hydrogeologic characteristics in that fractures control the occurrence and flow of groundwater. The climate can be classified as humid continental. Groundwater occurrence on the Precambrian Shield has not been studied except in a general way because the region is sparsely populated and bountifully endowed with surface water of good quality. No major

groundwater withdrawals from the bedrock are made. Numerous lakes and extensive wetlands are the most striking hydrographic features of many parts of the Shield. Surface waters and shallow groundwaters of the Canadian Shield region are generally very low in dissolved constituents. (See also W90-02866) (Fish-PTT)
W90-02881

REGION 13, WESTERN GLACIATED PLAINS.
Environment Canada, Ottawa (Ontario).
D. H. Lennox, H. Maathuis, and D. Pederson.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 115-128. 6 fig, 75 ref.

Descriptors: *Geohydrology, *Geohydrologic units, *Glaciohydrology, Aquifers, *Western Glaciated Plains Region, Geologic units, Geologic control, Groundwater movement, Geohydrologic boundaries, Surface flow, Paleozoic Era, Carbonate rocks, Sediments, Glacial sediments, Canada.

The Western Glaciated Plains region occupies an area in southern Canada and the northern United States. The region is both areally extensive and geologically diverse. Hydrogeologically, it provides the setting for a complex network of shallow, intermediate, and deep groundwater flow systems, which extend throughout the region from the land surface to the Precambrian basement. Three major generic groups of aquifers are identified on the basis of their geological setting. (1) The first group is found where Paleozoic carbonate rocks are near enough to the surface to serve as aquifers. Local recharge through overlying tills and fluvial deposits appears to be the predominant origin of groundwater in the upper zone of the Winnipeg carbonate aquifer. The primary importance of the Madison aquifer is as a source of recharge to overlying aquifers in Cretaceous sandstones; intergranular permeabilities of the individual rock types within the Madison aquifer are insignificant as compared with the permeabilities due to fracturing, brecciation, or karst development. (2) The second group is contained in vast wedges of clastic continental sediment. The Dakota aquifer has been generally considered to be the type example of a clastic artesian system; this formation is mostly continental in origin and consists of coastal-plain, fluvial, and flood-plain sediments deposited as Cretaceous shorelines. The Judith River formation of Alberta, Saskatchewan, and Montana, is typical of the regionally-extensive clastic wedges of Late Cretaceous and Early Tertiary age that form important aquifers in the western part of the region; the Late Cretaceous Fox Hills and Hell Creek formations and the Early Tertiary Fort Union formation and their equivalents form a continuous geological sequence in Montana, Alberta, Saskatchewan, North Dakota, South Dakota, and Wyoming. (3) The third grouping includes aquifers that are found in the glacial sediments. The complex glacial and interglacial history of the Western Glaciated Plains region has resulted in a distribution of surficial sand and gravel deposits that seems to some degree unpredictable; at the end of the Pleistocene, the alluvial deposits at the base of the preglacial and interglacial valleys were overlain with glacial drift, which generally tended to fill in the valleys and to obscure or conceal the earlier drainage networks. (See also W90-02866) (Fish-PTT)
W90-02882

REGION 14, CENTRAL GLACIATED PLAINS.
Indiana Univ., Bloomington. Dept. of Geology.
N. C. Krothe, and J. P. Kempton.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 129-132. 1 fig, 32 ref.

Descriptors: *Central Glaciated Plains, *Geohydrology, *Geohydrologic units, *Glaciohydrology, *Aquifers, *Glacial aquifers, Sand aquifers, Glacial drift, Bedrock, Sedimentary rocks, Geologic units, Geologic control, Groundwater movement, Geohydrologic boundaries, Geochemistry, Mineralogy.

The glaciated terrain of the north-central United States constitutes one of the most significant groundwater regions of North America. Extensive sand and gravel aquifers occur within the glacial drift; the underlying bedrock also contains extensive aquifer systems. The hydrogeologic settings that occur throughout the Central Glaciated Plains Region include areas of both thin and thick drift over sedimentary bedrock. Chemical evolution of the groundwater in this area is complicated by numerous geochemical processes, groundwater withdrawal, and Pleistocene glaciation. The chemistry of groundwater contained in glacial deposits is variable and depends on the mineralogy of the materials derived from glacial erosion of preexisting bedrock and unconsolidated deposits. (See also W90-02866) (Fish-PTT)
W90-02883

REGION 15, ST. LAWRENCE LOWLAND.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
R. N. Farvolden, and J. A. Cherry.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 133-140. 4 fig, 24 ref.

Descriptors: *St Lawrence Lowland, *Surface-groundwater relations, *Canada, *Geohydrology, *Geohydrologic units, Geologic units, Geologic control, Groundwater movement, Topography, Geohydrologic boundaries, Geochemistry, Humid climates, Paleozoic era, Sedimentary rocks, Glaciation, Alluvial aquifers, Clays, Aquitards, Water resources development, Water yield, Precipitation, Base flow, Streamflow, Runoff, Potable water, Great Lakes.

The St. Lawrence Lowlands region in the southern part of Canada encompasses the southern tip of the province of Ontario to the St. Lawrence River. The climate is a humid continental type with warm summers and cold winters. Relatively undeformed Paleozoic sedimentary rocks from Cambrian to Mississippian age overlie the Precambrian basement, and the local topography is dominated by the effects of Pleistocene Wisconsin glaciation. Some good river-connected aquifers occur in the Quaternary alluvium along streams and rivers. Surficial clay-rich Quaternary deposits exist in much of southwestern Ontario and are important because they severely restrict the vertical flow of recharge water into aquifers and because they usually have desirable characteristics for waste-disposal sites. Regional surveys of water resources in the St. Lawrence Lowlands have shown that water yield is about 50 percent of precipitation and that groundwater contributions to base flow make up about 40 percent of total streamflow. Tritium and Oxygen-18 have been used to show that even storm runoff in headwater catchments is mostly groundwater. Little evidence for regional groundwater flow has been found anywhere in the St. Lawrence Lowlands, perhaps because most potable groundwater occurs at shallow depths, so data are not available for the depths at which evidence of regional flow might be found. Most groundwater reaches the Great Lakes as stream flow originating from local groundwater flow zones. The hydrogeologic conditions require careful consideration in any attempts to avoid contamination of the lakes through groundwater transport. (See also W90-02866) (Fish-PTT)
W90-02884

REGION 16, CENTRAL NONGLACIATED PLAINS.
Geological Survey, Lawrence, KS.
D. G. Jorgensen, J. Downey, A. R. Dutton, and R. W. Maclay.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 141-156. 9 fig, 30 ref.

Descriptors: *Geohydrology, *Geohydrologic units, *Surface-groundwater relations, *Groundwater movement, *Central Nonglaciated Plains, Geologic units, Geologic control, Geohydrologic boundaries, Hydraulic properties, Precipitation, Evapotranspiration, Streamflow, Flow discharge, Aquifers, Physiographic provinces, Altitude, Flow system, Groundwater recharge, Montana, Texas.

The Central Nonglaciated Plains of North America extend from Montana to the Balcones Escarpment of central Texas. Climate, especially precipitation and evapotranspiration, is widely recognized as the dominant factor controlling streamflow, which plays a major role in modifying landforms in the region. The flow system of most regional aquifers is controlled by altitude of recharge and discharge areas. The Central Nonglaciated Plains have been subdivided into hydrophysiographic regions because several regional groundwater-water flow systems occur within them. (1) Northern Great Plains: All five of the regional water-yielding geohydrologic units crop out and receive some recharge in the highland areas of the Rocky Mountains and around the Black Hills. (2) Central Great Plains: Two important regional geohydrologic units are present in this region--the Western Interior Plains aquifer system and the Great Plains aquifer system. The present water-yielding characteristics of the rocks differ greatly from the characteristics of the original sediments; many of the highly-permeable zones in the Western Interior Plains aquifer system are probably paleokarsts. (3) Ozark Plateaus: This area includes the St. Francois Mountains, the Salem Plateau, and the Springfield Plateau. The present water-yielding characteristics of the rocks in the Ozark Plateaus are almost entirely the result of diagenesis and weathering that has taken place throughout geologic time. (4) Southern Great Plains: The groundwater system of this region comprises three heterogeneous geohydrologic units: the 'deep-basin brine' aquifer system, the 'evaporite' aquitard, and the 'High Plains aquifer system'. In most cases, the original hydraulic properties of rocks have been altered by diagenesis. (5) Edwards Plateau/Llano Hills/Balcones fault zone: The present-day hydrogeologic conditions of this region reflect the various depositional phases and subsequent diagenesis in different environments that have taken place through geologic time. (See also W90-02866) (Fish-PTT)
W90-02885

REGION 17, HIGH PLAINS.
Geological Survey, Denver, CO.
J. B. Weeks, and E. D. Gutentag.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 157-164. 5 fig, 8 ref.

Descriptors: *Geohydrology, *Geohydrologic units, *Aquifers, *Groundwater movement, *Groundwater recharge, *High Plains, Geologic units, Geologic control, Geohydrologic boundaries, Specific yield, Transmissivity, Storage capacity, Geochemistry, Arid climates, Agricultural watersheds, Aeolian deposits, Sand, Silt, Precipitation, Evaporation, Flow discharge, Fluvial sediments, Bedrock.

The High Plains region includes the central United States east of the Rocky Mountains in the southern part of the Great Plains. The High Plains aquifer, which underlies this region, is the principal source of water in one of the major agricultural areas in the United States. Most of the High Plains has a middle-latitude, dry continental climate. The climate is one of abundant sunshine, moderate precipitation, frequent winds, low humidity, and a high rate of evaporation. Typically, about 75% of the precipitation falls as rain. However, much of the rain results from local thunderstorms. Persistent winds and high summer temperatures cause high rates of evaporation. Because evaporative demand greatly exceeds precipitation, recharge to the High Plains aquifer is small except in areas of dune sand or sandy soil. Consequently, discharge from the aquifer to streams is small, and most streams draining the High Plains are intermittent. Wind-blown sand and silt, derived from the beds of rivers that eroded the plains, were deposited throughout large areas of the High Plains. The aeolian and fluvial sediments that compose the aquifer have relatively large storage properties. The specific yield ranges from 3 to 35% and averages about 15%. Where salt dissolution has occurred under competent rocks, collapse has caused chaotic structures in the now fractured rocks. The resulting surface depressions or sinkholes have been filled with fluvial sediments. Sinkhole formation and infilling has continued from Permian time to the present, creating complex and chaotic sedimentary structures. Consequently, the sinkhole deposits do not have the same groundwater flow characteristics as similar lithologic material deposited horizontally in areas without sinkholes. The chaotic bedding in the sinks greatly impedes regional groundwater flow. Dissolution of evaporites in Permian bedrock units has had a pronounced effect on the High Plains aquifer. Dissolution of salt by circulating groundwater has affected the quality of water in the overlying aquifer and in the streams draining the area underlain by Permian bedrock. Collapse and infilling have caused chaotic sedimentary structures that affect aquifer thickness and groundwater flow. (See also W90-02866) (Fish-PTT)
W90-02886

REGION 18, ALLUVIAL VALLEYS.
Geological Survey, Reston, VA.
J. S. Rosenshein.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 165-175. 9 fig, 18 ref.

Descriptors: *Alluvial valley aquifers, *Surface-groundwater relations, *Geohydrology, *Geohydrologic units, *Alluvial aquifers, Geologic units, Geologic control, Groundwater movement, Geohydrologic boundaries, Streamflow, Streams, Water resources development, Deposition, Sediments, Permeability, Hydraulic conductivity, Alaska, Canada.

Alluvial-valley aquifer-stream systems form long narrow systems that occur in many parts of the conterminous United States and in Alaska and Canada. The alluvial-valley aquifers are in hydraulic connection with associated streams, and the systems are typified by the relatively rapid interaction of surface water and groundwater. Although the aquifer-stream systems are of limited areal extent in comparison to most aquifer systems, they are among the most intensively used and most historically important to people and their development, both culturally and economically. The hydrogeology of aquifer-stream systems reflects a complex depositional environment. However, based on gross depositional characteristics, the sediments making up the aquifer form permeable hydrogeologic units that have, overall, a large hydraulic conductivity. (See also W90-02866) (Fish-PTT)
W90-02887

REGION 19, NORTHEASTERN APPALACHIANS.
Geological Survey, Albany, NY.
A. D. Randall, R. M. Francis, M. H. Frimpter, and J. M. Emery.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 177-187. 7 fig, 1 tab, 70 ref.

Descriptors: *Surface-groundwater relations, *Aquifers, *Northeastern Appalachians, *Groundwater pollution, *Geohydrology, *Geohydrologic units, Geologic units, Geologic control, Groundwater movement, Topography, Geochemistry, Igneous rocks, Metamorphic rocks, Sedimentary rocks, Carbonate rocks, Precipitation, Bedrock, Porosity, Solubility, Valleys, Yield, Glacial sediments, Erosion, Infiltration, Permeability, Water quality, Canada.

The Northeastern Appalachian region consists largely of hills and highlands in the mainland interior and in western Newfoundland. Dense igneous and metamorphic bedrock predominates, but porous unmetamorphosed sedimentary rocks and soluble carbonates and evaporites underlie some valleys and lowlands. Glacial erosion left a nearly continuous layer of till over bedrock. The most productive aquifers consist of coarse-grained stratified drift, but bedrock is more widely used and in some places provides large yields. Precipitation on the uplands can readily infiltrate the soil and sandy surficial till, but compact till and bedrock of lesser permeability commonly lie at shallow depth, and periodic saturation virtually to land surface is dem-

Group 2F—Groundwater

onstrated in many localities. Where the bedrock is relatively permeable, the till may remain unsaturated all year. The water-table configuration in uplands nearly replicates the topography throughout the region. Most of the bedrock in this region, and the glacial drift derived therefrom, is nearly insoluble. Consequently, concentrations of dissolved chemical species are low, even in deep wells. Soluble contaminants released at land surface commonly have a large and immediate influence on groundwater quality. The interchange of water between stratified-drift aquifers and streams is the outstanding feature of the hydrogeology of this region. (See also W90-02866) (Fish-PTT)
W90-02888

REGION 20, APPALACHIAN PLATEAUS AND VALLEY AND RIDGE.
P. R. Seaber, J. V. Brahana, and E. F. Hollyday.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 189-200. 5 fig, 1 tab, 38 ref.

Descriptors: *Appalachian plateau, *Valley and Ridge Region, *Aquifers, *Groundwater movement, *Geohydrology, *Geohydrologic units, Geologic units, Geologic control, Topography, Geohydrologic boundaries, Geochemistry, Climates, Mountains, Well yield, Permeability, Structural geology, Porosity, Karst hydrology, Canada, Alabama.

The Appalachian Plateaus and Valley and Ridge region is part of the Appalachian Sector, which lies in a long, narrow, curving band extending from Newfoundland, Canada, to central Alabama, United States. The region is subdivided into three subregions on the basis of hydrogeologic characteristics: the Valley and Ridge, the Appalachian Plateaus, and the Interior Low Plateaus. Compared to the more prolific regional aquifers of North America, aquifers in this region typically yield less water to wells. Groundwater flow paths are typically short, commonly extending no more than several tens of kilometers in their longest dimension. Because permeability in most of the indurated Paleozoic rocks is secondary, it decreases with depth. The occurrence, movement, storage, and chemical character of groundwater in the region is affected by numerous geologic controls, especially lithology, topography, and structure, and are evaluated with respect to the hydrogeologic parameters of permeability and porosity. Although hydrologic factors are important in the development and enhancement of secondary permeability and porosity and accompanying karst features in this area, no single geologic factor was dominant. (See also W90-02866) (Fish-PTT)
W90-02889

REGION 21, PIEDMONT AND BLUE RIDGE.
H. E. LeGrand.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 201-208. 4 fig, 17 ref.

Descriptors: *Piedmont and Blue Ridge Region, *Surface-groundwater relations, *Geohydrology, *Geohydrologic units, *Groundwater movement, Geologic units, Geologic control, Topography, Geohydrologic boundaries, Humid climates, Geochemistry, Confined aquifers, Surface drainage, Alkalinity, Acidity, Solutes, Clays, Geologic fractures, Bedrock, Sinks, Infiltration, Saturation zone, Dissolved solids, Hydrologic models.

The Piedmont and Blue Ridge region is considered as a collective unit for hydrogeologic purposes. The gross groundwater system in the region is not represented by a continuum, but is composed of countless relatively small groundwater units, each unit almost confined to each small surface drainage basin in which a perennial stream occurs. The climate is temperate and humid. Water occurs in two types of media: clayey granular weathered material and underlying fractures and other linear openings in the bedrock. A close network of streams prevails, with a continuous flow of groundwater toward streams, which are linear sinks in the water table. The path of natural movement of groundwater is relatively short. From a

point source of infiltration, water (or waste-bearing water) extends as a fan or expansive trail downgradient toward the stream. The saturated zone is not simple to define. Its top boundary is the water table, which lies in the clayey weathered material more often than not. The lower boundary is irregular and indistinct. The water table is near land surface in valleys and as much as eight to 20 meters below land surface beneath hills. Bedrock fractures tend to decrease in size and number with depth. Many fractures are enlarged by the action of solution. The distinctive chemical types of groundwater are present, including soft, slightly acidic water low in dissolved mineral constituents, and a hard, slightly alkaline water relatively high in dissolved solids. An understanding of the hydrologic system of fractured rocks of the region leads to conceptual models that are fundamental to evaluation. (See also W90-02866) (Fish-PTT)
W90-02890

REGION 22, ATLANTIC AND EASTERN GULF COASTAL PLAIN.
H. Meisler, J. A. Miller, L. L. Knobel, and R. L. Wait.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 209-218. 6 fig, 31 ref.

Descriptors: *Atlantic Coastal Plain, *Gulf Coastal Plain, *Geohydrology, *Geohydrologic units, *Coastal plains, *Groundwater recharge, Geologic time, Sedimentary rocks, Sediment distribution, Geohydrologic boundaries, Sand, Gravel, Deposition, Geologic units, Physiographic provinces, Permeability, Flow discharge, Geochemistry, Climates, Precipitation, Mineralogy, Calcium compounds, Sodium compounds.

The Atlantic and eastern Gulf Coastal Plain is a gently rolling to flat region of about 400,000 sq km extending from Long Island, New York, to eastern Mississippi. It is underlain by a wedge of unconsolidated to semi-consolidated, predominantly clastic sedimentary rocks that range in age from Jurassic to Holocene. The Coastal Plain sediments generally dip gently seaward; however, broad folds, arches, and embayments are superimposed on the Coastal Plain wedge, affecting the thickness and distribution of sediments. Coarse, permeable materials such as sand and gravel generally are present on or near the arches. Low-permeability sediments are generally thicker and more extensive in the eastern Gulf Coast. Permeability distribution in the clastic sediments is closely related to their environment of deposition, which in turn reflects geologic age. Thus, based on age and depositional environment, the Coastal Plain sediments are subdivided into four major hydrogeologic units. Precipitation is the source of freshwater recharge to the Coastal Plain sediments. Groundwater recharge varies considerably over the region, most importantly because of variability in the intake capacity of the sediments and a southward increase in evapotranspiration. The most striking differences in the mineralogy of the sediments is caused by the different depositional environments. Four hydrochemical facies are identified: variable composition, calcium plus magnesium bicarbonate, sodium bicarbonate, and sodium chloride. (See also W90-02866) (Fish-PTT)
W90-02891

REGION 23, GULF OF MEXICO COASTAL PLAIN.
Geological Survey, Austin, TX.
For primary bibliographic entry see Field 2A.
W90-02892

REGION 24, SOUTHEASTERN UNITED STATES.
Geological Survey, St. Simons Island, GA.
R. H. Johnston, and J. A. Miller.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 229-236. 5 fig, 2 tab, 11 ref.

Descriptors: *Floridan Aquifer, *Geohydrology, *Geohydrologic units, Aquifers, *Coastal plains, *Carbonate rocks, Geologic time, Geohydrologic

boundaries, Geologic units, Physiographic provinces, Permeability, Flow discharge, Clays, Deposition, Groundwater recharge, Geochemistry, Climates, Limestone, Groundwater movement, Solutes, Saline water intrusion, Pumping, Florida.

Unconsolidated to semiconsolidated sedimentary rocks of Jurassic to Holocene age underlie the Coastal Plain province of the southeastern United States. These strata, which include highly prolific carbonate aquifers, thicken seaward. Southeastern Coastal Plain sediments can be grouped into two general categories: (1) clastic rocks that contain minor amounts of limestone, and (2) a thick, sequence of platform carbonate rocks. The two major carbonate aquifer in the southeastern United States are the Biscayne aquifer and the Floridan aquifer system, separated from each other by a clayey confining unit. The distribution of permeability within the Floridan aquifer system is complex and depends partly on the original texture of the carbonate strata and partly on the postdepositional history of the rocks. The characteristic of the system that most strongly influences the distribution of natural recharge, flow, and discharge is the degree of confinement of the Upper Floridan. The Biscayne aquifer, generally highly permeable and containing water under unconfined conditions, is the major source of groundwater in much of southeastern Florida. The limestone parts of the aquifer are highly permeable because of the development of solution channels and cavities (some of which are sand-filled). Permeability is lower in the sandy parts of the aquifer. Saltwater encroachment is an ever-present threat to the Biscayne because the aquifer is unconfined and hydraulically connected to the sea, heavily pumped, and cut by a network of canals. (See also W90-02866) (Fish-PTT)
W90-02893

REGION 25, YUCATAN PENINSULA.
J. M. Lesser, and A. E. Weidie.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 237-241. 6 fig, 5 ref.

Descriptors: *Yucatan Peninsula, *Karst hydrology, *Groundwater recharge, *Groundwater movement, *Geohydrology, *Geohydrologic units, Geohydrologic boundaries, Geologic units, Physiographic provinces, Permeability, Flow discharge, Geochemistry, Humid climates, Coastal plains, Evapotranspiration, Infiltration, Carbonate rocks, Dolomite, Infiltration, Saline water intrusion, Precipitation, Mexico.

The Yucatan Peninsula, in the eastern portion of Mexico, is bounded on the west and north by the Gulf of Mexico; on the east by the Caribbean Sea; on the southwest it merges with the Gulf Coastal Plain; and on the south it is bounded by the Sierra Madre del Sur. The entire region is a well-developed karst plain. A humid tropical climate prevails, with high temperature and abundant vegetation causing about 85% of the rainfall to be lost through evapotranspiration; the remaining 15% infiltrates the subsurface; virtually no streams or surficial water bodies exist on the peninsula. Four distinct physiographic regions have been recognized. The peninsula is covered by horizontal Tertiary carbonates that overlie Cretaceous carbonates and evaporites. Most lithofacies have good permeability. In the southern and central portions of the peninsula the Paleocene and lower Eocene carbonates are dolomitic and, in part, slightly silicified. These rocks are pervasively fractured, permitting rapid infiltration and flow of groundwater. In the Yucatan Peninsula there are two sources of saltwater: (1) dissolution of evaporite deposits interbedded in the carbonate sediments, and (2) the sea water surrounding the peninsula. Rainfall over the peninsula infiltrates, and the fresh groundwater moves seaward toward the coastline. There is constant replenishment of fresh water in the upper part of the aquifer, and salinities increase at greater depths. Along the coastline there is saltwater intrusion into the fresh water aquifers. The near-horizontal Cenozoic carbonates of the peninsula are fractured extensively, providing major conduits of

seawater groundwater discharge and solution. (See also W90-02866) (Fish-PTT)
W90-02894

REGION 26, WEST INDIES.
Geological Survey, Reston, VA.
W. Back.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 243-254. 6 fig, 21 ref.

Descriptors: *West Indies, *Karst hydrology, *Islands, *Aquifer systems, *Geohydrology, *Geohydrologic units, *Coastal aquifers, Geohydrologic boundaries, Permeability, Flow discharge, Karst, Groundwater recharge, Geochemistry, Climates, Limestone, Dolomite, Alluvium, Coastal plains, Carbonates, Transmissivity, Well yield, Topography, Solutes, Groundwater movement.

The West Indies are considered to include the few thousand islands that compose the Greater Antilles and the Bahamas. The major aquifer systems and those of more restricted extent and production are composed of limestone and dolomite sequences, alluvial fill in coastal valleys, volcanic and intrusive rocks, and various types of coastal deposits such as coastal plain sands and gravels, beach ridges, and sand dunes. The geologic processes that have formed these aquifers include aspects of plate tectonics, volcanic eruptions, fluvial sedimentation, and deposition of carbonates. The occurrence, movement, and chemical character of groundwater are controlled by the lithology and permeability distribution of the aquifers and aquitards that make up the groundwater system, along with the climate and topography of the region. In the West Indies, the aquifers with highest transmissivity and, consequently, the largest well yields are composed of alluvium and karstified limestone; secondary aquifers are composed of limestone with a lower-degree dissolution and fractured igneous and metamorphic rocks. On the larger islands, groundwater is relatively abundant in the alluvium of the river valleys and in the permeable limestones and volcanic rocks. On the smaller islands, low-yielding aquifers are developed in the volcanic rocks. (See also W90-02866) (Fish-PTT)
W90-02895

REGION 27, HAWAIIAN ISLANDS.
Geological Survey, Honolulu, HI.
C. D. Hunt, C. J. Ewart, and C. I. Voss.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 255-262. 5 fig, 13 ref.

Descriptors: *Hawaii, *Islands, *Groundwater recharge, *Geohydrology, *Geohydrologic units, Geohydrologic boundaries, Geologic units, Groundwater reservoirs, Geologic history, Permeability, Groundwater movement, Flow discharge, Saline water, Infiltration, Rainfall-runoff relationships, Geologic control, Hydraulic properties, Saline-freshwater interfaces, Lava.

Although the Hawaiian Islands are surrounded by seawater, favorable circumstances cause the islands to be underlain by large quantities of fresh groundwater. Foremost among these circumstances is the role of the island masses in causing orographic rainfall. Favorable geologic conditions allow much of the abundant rainfall to accumulate as fresh groundwater. Permeable soils and rocks permit easy infiltration and subsurface movement of water, and low-permeability geologic features impound large amounts of water in thick groundwater reservoirs. The geology of the Hawaiian Islands is varied and is the end result of many processes including volcanism, erosion, subsidence, sedimentary deposition, and even glaciation. The geohydrologic framework of the Hawaiian Islands exerts characteristic controls on the occurrence and movement of groundwater. These controls result from small-scale hydraulic properties of the various rocks and from large geohydrologic barriers of volcanic, erosional, and depositional origin. The major occurrences of groundwater in Hawaii are (1) mostly unconfined freshwater lenses floating on saltwater in highly permeable, layered lavas; (2) freshwater impounded to high elevations in perme-

able lavas that are intruded by impermeable, vertical dikes; (3) freshwater perched on poorly permeable ash beds or soils within lavas or sediments; and (4) saltwater in volcanic or sedimentary rocks. (See also W90-02866) (Fish-PTT)
W90-02896

REGION 28, PERMAFROST REGION.
Geological Survey, Anchorage, AK. Water Resources Div.
C. E. Sloan, and R. O. van Everdingen.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 263-270. 3 fig, 15 ref.

Descriptors: *Geohydrology, *Geohydrologic units, *Permafrost, *Arctic zone, *Subarctic zone, *Alpine regions, Heat balance, Terrain analysis, Hydraulic conductivity, Specific heat, Thermal conductivity, Geohydrologic boundaries, Groundwater movement, Physiographic provinces, Permeability, Solubility, Geochemistry, Mineralization, Cold regions, Alaska, Canada.

Permafrost is defined as ground (rock or soil) with temperatures that have remained below 0 C continuously for two or more years. It is widespread in the arctic and subarctic regions of Alaska and Canada, and extends southward in the alpine zone of the western Cordillera of North America. The occurrence of permafrost is controlled by the surface heat balance, which in turn is influenced by terrain factors such as relief, slope aspect, vegetation, snow cover, moisture content, soil and rock type, and the presence of surface-water bodies. Freezing of a water-bearing soil or rock causes electrical and hydraulic conductivities to decrease, apparent specific heat capacity to decrease, and thermal conductivity to increase. Groundwater regimes in permafrost are affected by climatic effects and by the presence of perennially frozen ground. In discussing the hydrogeology of the permafrost region it is convenient to group aquifers under three major headings: (1) suprapermafrost (situated above the permafrost), (2) intrapermafrost (unfrozen zones within the permafrost), and (3) subpermafrost (below the permafrost). Permafrost can have a significant effect on the mineralization or chemical composition of groundwater, such as reduced dissolution rates, reduced groundwater movement, and increased solubilities of calcium and magnesium bicarbonates. (See also W90-02866) (Fish-PTT)
W90-02897

NATURE OF COMPARATIVE HYDROGEOLOGY.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2A.
W90-02898

ALLUVIAL AQUIFERS ALONG MAJOR RIVERS.
Texas Univ. at Austin. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2E.
W90-02899

WESTERN ALLUVIAL VALLEYS AND THE HIGH PLAINS.
G. H. Davis.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 283-300. 6 fig, 4 tab, 50 ref.

Descriptors: *Surface-groundwater relations, *Geohydrology, *Geohydrologic units, *Alluvial aquifers, Mountains, Geohydrologic boundaries, Geologic units, Physiographic provinces, Geochemistry, Climates, Groundwater potential, Alluvium, Particle size, Deposition, Dating, Compaction, Soil profiles, Weathering, North America.

The western alluvial valleys and the High Plains are the most extensive and productive groundwater systems in North America. The alluvial basins include the intermontane valleys of the Pacific mountain system (93,00 sq. km.) and the basins of

the Basin and Range Province (roughly 900,000 sq km in the United States and Mexico); the High Plains encompasses 458,000 square kilometers. In general, the physical characteristics of alluvial fills follow systematic patterns, i.e., the coarsest deposits are generally found where streams debouch from high mountains; the average grain size tends to decrease away from these foci, and interfan areas are characterized generally by finer deposits. Rates of deposition are difficult to calculate in alluvial deposits because little datable material survives. Once deposited, alluvium is immediately exposed to physical processes tending toward compaction and to the chemical effects of air, water, and organic matter. If not covered promptly by new deposits, soil profile development will begin. The principal sources of dissolved substances in the groundwater of the western alluvial valley fills are weathering of mineral matter in the soil and rocks of upland catchments and of the alluvial deposits themselves. Certain trends are common to most alluvial basins in the West, such as climatic patterns and their changes over time, isostasy, and volcanism. The thickness of alluvial fills is fairly consistent in the Pacific mountain system, and in the Basin and Range Province to the extent that it is known. Depositional regimes are similar throughout the West. (See also W90-02866) (Fish-PTT)
W90-02900

GLACIAL DEPOSITS.
Dames and Moore, Phoenix, AZ.
D. A. Stephenson, A. H. Fleming, and D. M. Mickelson.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 301-314. 5 fig, 4 tab, 70 ref.

Descriptors: *Sediments, *Aquifer systems, *Geohydrology, *Geohydrologic units, *Glacial drift, Glacial sediments, Geohydrologic boundaries, Geologic units, Sinks, Physiographic provinces, Permeability, Flow discharge, Groundwater recharge, Geologic time, Geochemistry, Waste disposal, Silt, Sand, Gravel, Clays, Hydraulic conductivity, Hydraulic properties, Sediment transport.

Glacial landscapes involve a complex mixture of sediment types that often have different hydrogeological properties. The single most important factor affecting hydrogeologic characteristics of glacial deposits is the diversity of sediments and the resultant numerous lithologic discontinuities. Glacial deposits (till, glaciofluvial sediments, glaciolacustrine sediments, and loess) in North America are primarily Quaternary in age, cover about 13 million sq km, and constitute both a sediment source for groundwater and, increasingly, a sink for waste disposal. All glacial deposits comprise silt, sand, or sand and gravel in addition to clay fractions and cobble/boulder fractions. The most characteristic geologic feature is the diversity in lithology, both laterally and vertically. The character of glacial sediments is a function of (1) lithology and geochemical properties at the sediment source; (2) sediment transport; and (3) sediment deposition. In a given geographic area, differences in till and other glacial sediments may be the result of single or several glacial episodes. Thus, aquifer systems are frequently of more concern than individual aquifers or aquitards. A knowledge of sedimentary environments in the glacial setting is essential to interpretation of the hydrogeology of glacial terrains. Glacial deposits are grouped into two general hydraulic categories: those that transmit groundwater readily and those with low hydraulic conductivity. The chemical composition and age of groundwater in glacial deposits are frequently quite variable over small distances. (See also W90-02866) (Fish-PTT)
W90-02901

COASTAL PLAIN DEPOSITS.
Geological Survey, Atlanta, GA.
J. A. Miller.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 315-322. 2 fig, 1 tab, 15 ref.

Group 2F—Groundwater

Descriptors: *Geohydrology, *Geohydrologic units, *Coastal plains, Sediment distribution, Geohydrologic boundaries, Geologic time, Erosion, Sediments, Physiographic provinces, Permeability, Geochemistry, Climates, Deposition, Sand, Silt, Saline water intrusion, Carbonate rocks, Structural geology, Clays, Confining beds, Topography, Groundwater movement, Artesian pressure.

Coastal Plain sedimentary rocks underlie an area extending from Cape Cod, Massachusetts, southward to the Florida Keys, then westward and southward around the periphery of the Gulf of Mexico and across the Yucatan peninsula where they form part of the western boundary of the Caribbean Sea. Coastal Plain rocks range in age from Jurassic to Holocene and generally thicken toward the shoreline. Coastal Plain rocks are generally easily eroded. The sediments underlying the Coastal Plain (consisting primarily of sand, silt, and clay) are all water-laid and were deposited during a series of transgressions and regressions of the sea. Carbonate rocks are less widespread than clastic sediments. The permeability of clastic Coastal Plain sediments is determined primarily by the texture and degree of sorting of the sediment. The geologic factors affecting permeability are: lithology, structure, topography, confining units, carbonate dissolution, and miscellaneous (geopressure, heavy pumping, and permeable basalt flows). Some of these factors have regional influence and some have only local effects. The overall pattern of groundwater flow in major aquifers in Coastal Plain rocks is that of a classic artesian system. Most of the flow is perpendicular to the coastline. Salt water is present in many Coastal Plain aquifers either onshore or offshore. (See also W90-02866) (Fish-PTT)
W90-02902

SANDSTONES AND SHALES.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
S. N. Davis.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 323-332. 3 fig, 4 tab, 61 ref.

Descriptors: *Sandstones, *Shales, *Geohydrology, *Geohydrologic units, *Aquifer systems, Geohydrologic boundaries, Geologic units, Permeability, Groundwater recharge, Geochemistry, Artesian wells, Waste disposal, Clays, Sedimentary rocks, Deposition, Compaction, Cements, Erosion, Porosity, Particle size, Geologic fractures, Dissolved solids, Saline water, Basins.

Early development of artesian wells about a century ago in the central part of the United States stimulated a contemporary interest in the sandstone aquifers that are widespread in the region. Problems of aquifer recharge, variable natural water chemistry, and confinement of artificially emplaced waste are related closely to the hydrogeologic properties of fine-grained clastic rocks. Furthermore, in terms of their total mass, clays and shales account for more than 65% of the volume of all the sedimentary rocks. A simple classification of clastic rocks is based primarily on texture. The texture, lateral continuity, thickness, and overall shape of sedimentary units are controlled in a large measure by the original environments of deposition of the sediments and secondarily by their postdepositional compaction, cementation, erosion, folding, and faulting. These factors in turn establish the hydrologic and chemical characteristics of the hydrogeologic units. Generally, the porosity of sandstone decreases gradually with depth. Grain size plays a dominant role in determining the permeability of the rock. Very roughly, the permeability increases as the square of the grain size. All deep basin studies show a general decrease in porosity of shale with depth. Secondary fractures add a small but important porosity. The total dissolved solids (TDS) in groundwater from sandstone varies from less than 30 mg/L in some shallow aquifers of the Atlantic and Gulf coastal regions to brines approaching saturation with respect to halite in deep sandstones within several sedimentary basins in North America. (See also W90-02866) (Fish-PTT)
W90-02903

CARBONATE ROCKS.
Geological Survey, Nashville, TN.
J. V. Brahana, J. Thrailkill, T. Freeman, and W. C. Ward.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 333-352. 4 fig, 4 tab, 85 ref.

Descriptors: *Karst, *Geohydrology, *Geohydrologic units, *Carbonate rocks, *Groundwater potential, Geohydrologic boundaries, Geologic units, Permeability, Geochemistry, Well yield, Porosity, Diagenesis, Confining beds, Stratigraphy, Structural geology, Tectonics, Weathering, Geomorphology, Solutes, Precipitation, Groundwater movement.

The hydrogeology of carbonate rocks is more variable than that of any other major rock type. Whereas some carbonate formations are among the most permeable and productive aquifers known, others have such low permeability that they serve as major confining layers and yield virtually no water to wells. The factors that affect the evolving porosity and permeability of carbonate rocks are diagenetic, geochemical, lithologic-stratigraphic, structural-tectonic, hydrologic, weathering-geomorphic, and historical geologic-chronologic. The broad diversity of the hydrogeology of carbonate rocks is the result of variable combinations of more than 60 processes and controls that act on these rocks, two of which seem to dominate. The first process, dissolution and precipitation, describes geochemically the relative ease with which the fresh water interacts with the solid rock matrix of the aquifer to create varying permeability. The second process, dynamic freshwater flow, is essential if significant permeability evolution in a carbonate aquifer is to occur. The many other processes and controls that occur have varying influence on the two dominant factors, and often the influence can be significant. The variation strongly suggests that no factor should be omitted from consideration. (See also W90-02866) (Fish-PTT)
W90-02904

VOLCANIC ROCKS.
Geological Survey, Reston, VA.
W. W. Wood, and L. A. Fernandez.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 353-365. 9 fig, 4 tab, 25 ref.

Descriptors: *Volcanic rocks, *Groundwater, *Geohydrology, *Geohydrologic units, *Igneous rocks, Geohydrologic boundaries, Geologic units, Permeability, Groundwater recharge, Geochemistry, Climates, Solutes, Groundwater movement, Volcanoes, Porosity, Topography, Mineralogy, Confined groundwater, Tectonics, Basalts, Meteoric water.

The occurrences, movement, and solute concentrations of groundwater in volcanic rocks are controlled by geologic factors (porosity, intrinsic permeability, topography, mineralogic composition, etc.). These factors reflect different geodynamic emplacement processes and are interrelated with hydrologic factors (recharge flux, concentration of atmospheric gases, climate, vegetation, artesian or water table condition, etc.). Pyroclastic rocks typical of convergent plates and continental hot spots exhibit a wide range of geohydrologic properties. Ash-flow tuffs typically exhibit distinct increases in fracture density in the middle to lower part of a flow associated with increased welding. Flood basalts tend to exhibit less fracturing in the middle to lower section of a given cooling unit. However, the interflow zone comprising the top of one flow and the bottom of the next frequently tends to exhibit high porosity and permeability. Concentrations and ratios of major solutes are controlled more by the type of reactions than by the primary mineralogy of the rocks. Whether an aquifer is confined or unconfined makes a greater difference than does the rock type. Geothermal systems are common in many geologically young volcanic systems and have been shown to have been formed largely from the heating of local meteoric water. (See also W90-02866) (Fish-PTT)
W90-02905

PLUTONIC AND METAMORPHIC ROCKS.
Geological Survey, Menlo Park, CA.
F. W. Trainer.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 367-380. 4 fig, 86 ref.

Descriptors: *Geohydrology, *Geohydrologic units, *Crystalline rocks, *Plutonic rocks, *Igneous rocks, *Groundwater, *Metamorphic rocks, Geohydrologic boundaries, Geologic units, Permeability, Geochemistry, Plutonic water, Geologic fractures, Bedrock, Deformation, Stress, Structural geology, Aquifer systems, Metamorphic water, Topography, Connate water, Magmatic water, Isotope studies, Saline water, Weathering.

Plutonic and metamorphic (crystalline) rocks form the basement in North America, and are exposed over much of the continent. The crystalline rocks differ from unconsolidated deposits in possessing little primary permeability except where weathered. Groundwater in crystalline rocks therefore occurs principally in fractures. Fractures are commonly tighter and less abundant with increasing depth beneath the surface (related to the state of stress in the crust). Fractures are deformable, and they reflect temporal change and spatial variation in stress. Fracture types include: microfractures and pores, joints, faults, and linear features. Summaries of permeability data indicate a wide range in values for any given type of rock. What is known for fracture permeability in crystalline rocks suggests a wide range, large areal diversity, sharp decrease with increasing depth near the surface, and very low values generally at depth. Near-surface fractured rock forms extensive aquifers in many regions of crystalline rocks. The character of such an aquifer results from the combined effects of fracture system, topography, and weathering. The combination of chemical and isotopic approaches is leading to new progress in study of connate, metamorphic, and magmatic waters. A significant aspect of the hydrology of the plutonic and metamorphic rocks is the widespread occurrence of salty water in crystalline-rock terranes. There is a significant hydrogeologic contrast between crystalline/consolidated rocks and unconsolidated deposits whose permeability is largely or entirely primary; this difference leads to a fundamental difference in aquifer analysis. (See also W90-02866) (Fish-PTT)
W90-02906

GROUND WATER AS A GEOLOGIC AGENT.
Texas A and M Univ., College Station. Dept. of Geology.
P. A. Domenico.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 381-382. 14 ref.

Descriptors: *Geohydrology, *Geohydrologic units, *Aquifer systems, *Geologic deformation, *Deformation, *Tectonics, *Groundwater movement, Rock properties, Structural geology, Geohydrologic boundaries, Geologic units, Geochemistry, Stress, Strain, Interstitial water, Mass transfer, Energy transfer, Temperature effects, Thermodynamics, Deformation, Deposition.

The role of groundwater in performing geologic work has long been a topic of interest in the earth sciences. Common to all such processes is an understanding that underground fluid does not reside in a passive porous solid, but instead there exists a complex coupling between the moving fluid, entities that may be carried by the fluid, and the solid matrix itself. This coupling, or rock-water interaction, may be categorized within three broad groups: (1) the coupling between stress, strain, and pore fluids; (2) mass and energy transport (the processes that move mass or energy from one point to another in a porous medium) within saturated porous solids; and (3) mass and energy transfers (the manner and the rate at which mass or energy contained in one phase may be transferred to another). Another type of coupling between the transport and transfer is that the physical phenomenon (transport) often intrudes upon the chemical or thermodynamic phenomenon (transfer).

Under these categories are included the temperature-dependent liquid-forming phase transformations. Many of the important rock-water interactions involved in geologic processes can be viewed as problems in mass and energy transport and transfers in deformable bodies, where the deformation can be contemporaneous with deposition, or may occur during uplift, or may be absent entirely. The driving forces responsible for water movement assume paramount importance in modern as well as paleohydrologic regimes. (See also W90-02866) (Fish-PTT)
W90-02907

LANDFORM DEVELOPMENT.

California Univ., Davis. Dept. of Geology.
C. G. Higgins, D. R. Coates, V. R. Baker, W. E. Dietrich, and T. Dunne.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 383-400. 15 fig, 63 ref.

Descriptors: *Geohydrology, *Land forming, *Subsurface water, *Geomorphology, Vadose water, Unsaturated flow, Weathering, Soil genesis, Landscaping, Mass wasting, Slope degradation, Gullies, Pipes, Karst hydrology, Saturation zone, Permafrost, Subsidence, Springs, Valleys, Surface water, Topography, Sediments.

Subsurface water affects near-surface processes and landforms in a wide variety of ways. Some effects of water in the vadose or unsaturated zone above the water table are: weathering and soil development and their influence on landscape; mass wasting and slope failure; and hillslope hydrology, with its influence on piping and pseudokarst and on development of hillslopes and gully heads. The role of water in the saturated zone at or beneath the water table has effects on permafrost and pseudokarst, land subsidence, spring sapping and valley network development, submarine landforms, sea cliffs, scarp retreat, and surface stream channels. Ways in which regional geomorphology can control groundwater behavior and hydrology are topography and general terrain conditions, hydrologic properties of sediments, landforms, and slope aspect and orientation. (See also W90-02866) (Fish-PTT)
W90-02908

LANDFORM DEVELOPMENT; KARST.

McMaster Univ., Hamilton (Ontario). Dept. of Geography.
D. C. Ford, A. N. Palmer, and W. B. White.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 401-412. 7 fig, 35 ref.

Descriptors: *Geohydrology, *Geohydrologic units, *Karst hydrology, *Karst, *Groundwater, *Geomorphology, Bedrock, Erosion, Limestone, Dolomite, Gypsum, Salts, Rock properties, Structural geology, Tectonics, Topography, Land forming, Subterranean streams, Geohydrologic boundaries, Geologic units, Carbonates, Permeability, Flow discharge, Geochemistry, Climates, Solutes, Cavern flow.

Karst landscapes are the foremost examples of groundwater erosion. The sculpturing and removal of bedrock is predominantly by solution, aided in some cases by soil piping and collapse. Karst landforms develop best in limestones and dolomites, gypsum, and salt. When fully developed, the karst system has three morphological components: input landforms that direct waters underground, subterranean conduit systems, and discharge areas, (which include springs), sapping landforms, and erosion residual features such as rock towers. Karst terrains have been divided into 'holokarst' and 'merokarst' (or 'fluviokarst'). Major factors contributing to a great diversity of karst forms and combinations include: physical and chemical variations in the rocks themselves; geologic structure and tectonic history; relief and regional topography; geomorphic history, including paleokarst in some instances; and past and present climatic conditions. To understand the solutional properties of the karst environment it is important to review chemical processes (carbonate equilibrium, open

and closed systems, solute concentrations at equilibrium, and kinetics) and karst denudation. The suite of input landforms include karren (surfaces and subcutaneous processes) and closed depressions. The development of solutional cave systems can be understood in terms of karst aquifers and initial conditions; modeling the initiation and propagation of conduits; and common cave systems (building the plan patterns, vertical structure, evolution within a single stage, multi-stage caves, and some special cases of solutional development). (See also W90-02866) (Fish-PTT)
W90-02909

GROUND WATER AND CLASTIC DIAGENESIS.

Alberta Univ., Edmonton. Dept. of Geology.
F. W. Schwartz, and F. J. Longstaffe.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 413-434. 14 fig, 1 tab, 113 ref.

Descriptors: *Diagenesis, *Geohydrology, *Deposition, *Geohydrologic units, *Water chemistry, *Sedimentation, Geohydrologic boundaries, Geologic units, Geochemistry, Mass transfer, Groundwater movement, Temperature effects, Basins, Advection, Carbonates, Clays, Cements, Quartz, Organic matter.

The term diagenesis refers to changes that occur in a sediment following deposition. These changes are the outcome of a diverse and complex array of physical, chemical, and biological processes. Fundamental concepts of mass transport provide a useful framework for interpreting diagenetic processes; diagenesis is fundamentally a process of mass transport that is dependent on moving groundwater to redistribute mass in the system and to determine temperature and pressure. To explain the diagenesis of a given rock sample probably requires an understanding of mass transport and fluid flow on a basinwide scale. It is necessary to understand advection (depositionally active sedimentary basins, depositionally inactive basins, small-scale flow systems, and limitations in the application of transport concepts), dispersion (mixing of meteoric and formation waters), chemical and biological processes, and types of reaction. Key diagenetic minerals and reactions are those of carbonate cements, quartz, clay cements and the alteration of feldspar, and the role of organic matter. Good progress has been made in placing the study of diagenesis in a more complete conceptual framework and even using the patterns of diagenetic change as indicators of paleoflow regimes. (See also W90-02866) (Fish-PTT)
W90-02910

GENERATION AND DISSIPATION OF ABNORMAL FLUID PRESSURES IN ACTIVE DEPOSITIONAL ENVIRONMENTS.

Texas A and M Univ., College Station. Dept. of Geology.
P. A. Domenico, and V. V. Palciauskas.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 435-445. 4 fig, 3 tab, 41 ref.

Descriptors: *Sedimentation basins, *Fluid mechanics, *Deposition, *Diagenesis, *Geomorphology, *Geohydrology, Porosity, Sediment load, Hydrostatic pressure, Deformation, Stress, Thermal stress, Subsidence, Thermal expansion, Geologic units, Permeability, Geochemistry, Tectonics, Interstitial water.

The important diagenetic process of sediment compaction in a depositional environment involves the weight of other material which ultimately provides for porosity reduction associated with the packing into a smaller space; the added sediment load is initially carried by the water contained in the sediments, causing the fluid pressure to rise above its hydrostatic value. With the diffusion of pore water to areas of lower pressure, the sediment load is ultimately transferred to the matrix of skeletal grains, causing the deformation. From the perspective of abnormal pressure environments, the length of time required for this stress transfer to take place is of concern, for this is the time period over

which anomalously high fluid pressures may persist. Basin subsidence assures that the sediments and their contained fluids become subjected to a thermal field. Hence, additional components of anomalous fluid pressures evolve, largely due to the thermal expansion of water and water-release mechanisms associated with phase transformations. The study of excess pressure development in depositional environments is the study of competing rates of fluid-pressure production and dissipation. The effective stress concept, continuous loading and tectonic compression (pressure generation and dissipation, constant fluid volume, and pressure generation and dissipation: horizontal displacements not constrained to zero), thermal expansion of fluid (constant fluid mass and pressure production and dissipation), and phase transformations must be examined. (See also W90-02866) (Fish-PTT)
W90-02911

GROUND WATER AND FAULT STRENGTH.

Geological Survey, Menlo Park, CA.
S. A. Rojstaczer, and J. D. Bredehoeft.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 447-460. 7 fig, 2 tab, 70 ref, append.

Descriptors: *Groundwater, *Geohydrology, *Geologic fractures, *Hydrodynamics, *Fluid mechanics, Friction, Fluid flow, Fault springs, Groundwater movement, Pressure conduits, Hydrostatic pressure, Permeability, Rupturing, Injection, Seismic properties, Field tests, Interstitial water.

The influence of pore fluids on crustal failure is a relatively recent field of study. Natural mechanisms that raise the pressure of groundwater in any fault zone may strongly reduce fault strength. Many observations that have been made along exhumed ancient fault zones can be readily explained if groundwater exists in the mid-to-upper crust at pressures that approach lithostatic. Models which attempt to describe the interaction of groundwater and fault rupture must involve the interaction between groundwater and fault rupture-depth constraints; groundwater and fault strength (theory); injection induced seismicity (implications for the state of effective stress at frictional failure); and permeability and the influence of pore fluids on fault strength under natural conditions. Three cases of induced seismicity are examined, but provide neither a complete nor an exhaustive field-scale test of laboratory observations, because of uncertainty in the value of at least one of the parameters that control frictional failure. In determining whether or not fluid-pressurization mechanisms that are of sufficient strength to significantly influence fault motion within the upper crust exist under natural conditions, a simple analysis indicates that in areas where low-permeability argillaceous materials are not present in large volume, modest pore-fluid pressurization under natural conditions is limited to processes that operate at very high rates. Pressure-producing mechanisms that operate at a moderate rate within the upper crust will probably only influence fault strength if the faults contain large amounts of poorly permeable and/or highly compressible fault gouge. (See also W90-02866) (Fish-PTT)
W90-02912

ROLE OF GROUND-WATER PROCESSES IN THE FORMATION OF ORE DEPOSITS.

Texas Univ. at Austin. Dept. of Geological Sciences.
J. M. Sharp, and J. R. Kyle.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 461-483. 12 fig, 3 tab, 182 ref.

Descriptors: *Ore formation, *Geochemistry, *Geohydrology, *Hydrodynamics, *Groundwater movement, Economic aspects, Fluid mechanics, Fluid flow, Meteoric water, Minerals, Geologic time, Sedimentation, Continental hydrology, Plutonic water, Marine environment, Metamorphic water, Mineralogy, Infiltration, Geohydrologic

boundaries, Geologic units, Permeability, Flow discharge, Geochemistry.

Groundwater is of paramount importance in a wide variety of ore-forming processes, but the hydrodynamics of these processes have only recently been the subject of quantitative investigations. The relationship of hydrogeology to economic geology for a wide range of ore deposits can be made. The hydrogeologic framework may be examined with respect to source of water, mechanism for fluid flow, source of ore components, transport mechanisms, and mechanisms of ore deposition. Ore deposits within the hydrogeologic framework occur in shallow meteoric environments, deeper sedimentary environments, shallow continental plutonic environments, marine volcanic environments, and metamorphic environments. In only a few cases have the actual hydrodynamics of fluid migration been intensively investigated. Mineral deposits may form where meteoric waters infiltrate into the earth, where groundwater discharges, where mineralizing fluids migrate into a zone of different chemical or physical properties, or where fluids of differing chemical composition or temperature mix. Analytical or numerical hydrogeologic models are capable of predicting times and rates of fluid movement in mineral deposit environments. The consideration of hydrogeologic concepts by economic geologists may lead to new or revised theories of mineral deposition. The most potentially promising line of future research is the assessment of how the groundwater system changes over geologic time. When this is understood, hydrogeology may prove much more useful in the field of mineral exploration. (See also W90-02866) (Fish-PTT)
W90-02913

GROUND WATER AND HYDROCARBON MIGRATION.
Alberta Univ., Edmonton. Dept. of Geology.
J. Toth.
IN: Hydrogeology. The Geological Society of North America, Boulder, Colorado. 1988. p 485-502. 22 fig, 56 ref.

Descriptors: *Geohydrology, *Hydrocarbons, *Oil-water interfaces, *Exploration, *Groundwater movement, Oil recovery, Subsurface water, Basins, Geohydrologic units, Geohydrologic boundaries, Geologic units, Geochemistry, Geophysics.

An understanding of the role of groundwater in the migration and accumulation of petroleum may aid in exploration, as hydrocarbons are thought to move in the subsurface either as a separate phase or along with water. Therefore it is necessary to understand the current principal concepts and models of petroleum migration; petroleum migration as an example for the geologic agent of groundwater flow; and the potential ramifications of this agent with respect to petroleum exploration. These objectives are accomplished by: reviewing the process, factors, and mechanisms that control the transport, concentration, and entrapment of hydrocarbons; reviewing representative models that attempt to fit the above controls into the context of the basins' evolutionary history; relating petroleum migration to other hydrogeologic processes and phenomena through the hydraulic theory of petroleum migration; and by outlining a hydrogeological approach to petroleum exploration. The hydraulic theory postulates a genetic relationship between a variety of hydrogeologic phenomena and regional groundwater flow. With respect to their relations to petroleum deposits, the other manifestations of groundwater flow may be classified as indirect and direct indicators of petroleum depending on whether they reflect potential conditions for accumulation and entrapment or the actual presence of deposits. By applying hydrogeological principles and techniques, the conventional arsenal of geology, geophysics, and organic geochemistry of the explorationist may be broadened by a hydrogeological approach to basin analysis and petroleum exploration. (See also W90-02866) (Fish-PTT)
W90-02914

COMPUTATIONAL METHODS IN WATER RESOURCES: VOL. 1. MODELING SURFACE AND SUB-SURFACE FLOWS.
For primary bibliographic entry see Field 7C.
W90-02980

VECTORIZED PROGRAMMING ISSUES FOR FE MODELS.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
For primary bibliographic entry see Field 7C.
W90-02982

PARAMETER IDENTIFICATION AND UNCERTAINTY ANALYSIS FOR VARIABLY SATURATED FLOW.
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W90-02983

MODELING OF HIGHLY ADVECTIVE FLOW PROBLEMS.
Rice Univ., Houston, TX. Dept. of Mathematical Sciences.
For primary bibliographic entry see Field 7C.
W90-02984

CROSS-BOREHOLE PACKER TESTS AS AN AID IN MODELLING GROUND-WATER RECHARGE.
Orange Free State Univ., Bloemfontein (South Africa). Inst. vir Grondwaterstudies.
For primary bibliographic entry see Field 7B.
W90-02985

BOUNDARY ELEMENT METHOD (GREEN FUNCTION SOLUTION) FOR UNSTEADY FLOW TO A WELL SYSTEM IN A CONFINED AQUIFER.
Nanjing Univ. (China). Dept. of Mathematics.
For primary bibliographic entry see Field 7C.
W90-02986

FINITE ELEMENT SOLUTION OF GROUND-WATER FLOW PROBLEMS BY LANCZOS ALGORITHM.
Universidade Federal do Rio de Janeiro (Brazil). Coordenacao dos Programas de Pos-graduacao de Engenharia.
A. L. G. A. Coutinho, L. C. Wrobel, and L. Landau.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 59-64, 2 tab, 11 ref.

Descriptors: *Groundwater movement, *Algorithms, *Finite element method, Mathematical equations, Seepage, Dam foundations, Computer programs, Performance evaluation, Comparison studies.

A procedure for finite-element (FE) solution of groundwater flow problems using the Lanczos algorithm was developed and compared with the conjugate gradient (CG) method with respect to computational efficiency. FE discretization of the flow for groundwater obeying Darcy's law yields a system of algebraic equations that can be expressed as A u = b, where A is a n x n symmetric, banded positive definite matrix, b is the known independent vector arising from boundary conditions, and u is the desired solution. The Lanczos algorithm is an oblique projection method that constructs weak forms of this equation in the subspaces spanned by the Krylov sequence. The seepage below a concrete dam under an impervious foundation, which was solved analytically by Cheng, was used as the model problem. Results obtained using 4-noded isoparametric elements with 2 x 2 Gauss integration, for two meshes

comprising 10 x 20 (200) and 20 x 40 (800) elements were compared using five methods: CG, CG with Jacobi regularization, modified CG with Jacobi regularization, Lanczos algorithm, and Lanczos algorithm with Jacobi regularization. Analyses were conducted on a Burroughs A-10 computer and the algorithms were coded in FORTRAN. Number of iterations, CPU time, and input/output time using the Lanczos algorithm compared favorably with results obtained with the CG method. Convergence was obtained within a factor of 0.001. The results obtained agreed well with those obtained analytically by Cheng and improved as the mesh was refined. (See also W90-02980) (Rochester-PTT)
W90-02987

FINITE ELEMENT MODEL OF FRACTURE FLOW.
Notre Dame Univ., IN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W90-02988

FINITE ELEMENT MODELING OF THE RURSCHOLLE MULTI-AQUIFER GROUND-WATER SYSTEM.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
H.-W. Dorgarten.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 71-76, 2 fig, 8 ref.

Descriptors: *Finite element method, *Hydrologic models, *Model studies, *Statistical models, *West Germany, *Mine drainage, *Groundwater movement, *Aquifers, Pumping, Water table, Mathematical models, Simulation, Computers, The Netherlands, Artificial recharge, Environmental effects.

The West German region between Aachen and Cologne is a major lignite reservoir, from which open-pit lignite mining is anticipated to occur to pit depths of 600 m by the year 2100. Because pumping is required to keep the pits dry, significant lowering of regional water tables will occur. The future groundwater situation was simulated using a quasi-three-dimensional mathematical model that involved finite element discretization of about 28,000 elements and more than 10,000 nodes. This model, the Rurscholle multi-aquifer model, was executed on a Cray X-MP supercomputer, covering a time period of 125 yr in time-steps of 3 mo and 2.5 yr. Results showed a wide-ranging decline of phreatic groundwater table by more than 1 m, which may result in various ecological effects. Depression of groundwater in the lower aquifers is about 200 m near the pits and several meters far beyond the German border in the Netherlands. Based on these results, several countermeasures were simulated with the model: (1) reducing pit volume, which could lead to an earlier refilling of the groundwater reservoir and saving of nearby rivers; (2) building injection wells to the bottom of the first aquifer to save ecologically valuable areas from groundwater decline; (3) raising the water table through artificial groundwater recharge, which would require high pumpage rates in the pits; and (4) using pit water for water supply, which would allow certain other groundwater reservoirs to be saved. (See also W90-02980) (Rochester-PTT)
W90-02989

COMPUTATION OF FLOW THROUGH A COMPOSITE POROUS DOMAIN.
Pretoria Univ. (South Africa). Dept. of Mechanical Engineering.
J. P. du Plessis.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference

on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 77-82, 5 ref.

Descriptors: *Mathematical models, *Hydrologic models, *Model studies, *Groundwater movement, *Porous media, *Permeability, Porous media, Porosity, Flow nets, Mathematical equations.

Recent developments in the continuum theory of flow through porous media permit the implementation of one general equation, which governs the flow in all parts of a composite medium. Only two parameters, the porosity (void fraction) and the microscopic length scale, are needed to describe the hydrodynamic permeability locally within each control volume of the flow domain. This unified approach can be used to predict flow characteristics through a composite domain consisting of sections of porous media with different permeabilities. Some aspects of the computational application of this method are discussed with reference to a finite volume numerical procedure. It is shown that an internal jump in permeability, which defines the interface between different porous media, can be treated without the explicit matching of flow properties on either side of the interface. The procedure outlined here has been applied and preliminary results are very promising. Flow past a porous obstruction (porosity = 0.976, microscopic characteristic length = 0.001) in a straight tube has been modeled to investigate the effect of so-called inertial terms of microscopic shear factor in the non-Darcy region of intermediate Reynolds number flows. Preliminary results for flow past a porous sphere yield flow patterns almost identical to that given by experimental flow visualization. The simplistic method described here thus seems capable of capturing the essential features of flow through composite porous media. The advantages of the present approach are the relative ease by which existing codes for free flow can be altered to handle composite porous flows, the elimination of matching problems at internal boundaries or interfaces, and the consistency of the equations at extremal values of the hydrodynamic permeability. Although a two-dimensional application is discussed here, the present model is also directly applicable to three-dimensional cases of porous flows. (See also W90-02980) (Rochester-PTT)
W90-02990

TWO PERTURBATION BOUNDARY ELEMENT CODES FOR STEADY GROUNDWATER FLOW IN HETEROGENEOUS AQUIFERS.
Lagos Univ. (Nigeria). Hydraulic Research Unit.
For primary bibliographic entry see Field 7C.
W90-02991

THREE-DIMENSIONAL FINITE ELEMENT-FINITE DIFFERENCE MODEL FOR SIMULATING CONFINED AND UNCONFINED GROUNDWATER FLOW.
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
A. S. Mayer, and C. T. Miller.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 89-94, 4 fig, 7 ref. EPA Assistance Agreement

Descriptors: *Statistical models, *Model studies, *Hydrologic models, *Groundwater movement, *Finite element method, *Finite difference methods, Algorithms, Computer models, Simulation analysis, Confined groundwater, Unconfined aquifers, Comparison studies, McDonald-Harbaugh Model, ALALS algorithm, Mathematical analysis, Performance evaluation.

Application of three-dimensional groundwater flow models often has been constrained by computer core storage and CPU time requirements, especially for unconfined flow problems. A previously developed algorithm, the alternate sublayer and line sweep (ALALS) algorithm, is extended here to the case of unconfined flow. Results from the numerical model were tested with flow problems amenable to analytical solution. In the first case, a transient unconfined flow in a single layer was simulated, and the results was compared with those from the Theis equation, with specific yield as the storage term, adjusted for non-constant transmissivity with the Jacob correction. The second validation consisted of a transient, radially convergent, confined flow problem with a partially penetrating well. The simulation was performed using 29 layers with a stress located only in the bottom 10 layers. This result was compared with Hantush's analytical solution. The U. S. Geological Survey's McDonald-Harbaugh model was used to provide benchmark for accuracy and efficiency of the present model. The three-dimensional ALALS algorithm accurately simulated unconfined groundwater flow. The model compares favorably with the McDonald-Harbaugh model in terms of computation efficiency, accuracy, and the ability to handle difficult conditions such as the draining and refilling of model elements. (See also W90-02980) (Rochester-PTT)
W90-02992

GALERKIN FINITE ELEMENT MODEL TO SIMULATE THE RESPONSE OF MULTILAYER AQUIFERS WHEN SUBJECTED TO PUMPING STRESSES.
Florida Inst. of Tech., Melbourne. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W90-02993

FINITE ELEMENT BASED MULTI LAYER MODEL OF THE 'HEIDE TROUGH' GROUNDWATER BASIN.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
B. Pelka.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 101-106, 4 fig, 4 ref.

Descriptors: *Model studies, *Hydrologic models, *Finite element method, *Groundwater basins, *Statistical models, *North Sea, Mathematical models, Simulation, Comparison studies, Management planning, Geologic properties, Boundaries, Geohydrology, West Germany, Alternative planning.

As a part of the groundwater management master plan for Dithmarschen, a region in North Germany near the North Sea, a multi-layer model was implemented to optimize and coordinate the development and management policies of seven public and industrial waterworks. A complicated geological and hydrogeological situation, characterized by several glacial geological processes, had to be abstracted to become input for the numerical multi-layer model. The model included large marsh regions and a surface drained by distributed patterns of field ditches, which are simulated by an areal leakage boundary condition. A successful calibration of different model parameters was achieved by performing a stepwise calibration according to the priority of influence. The model has been used to simulate several management alternatives and global and regional water balances have been evaluated. The simulation results show the consequences of various discharge alternatives. In addition, they help identify management alternatives of minor economic or ecological value. (See also W90-02980) (Author's abstract)
W90-02994

THREE-DIMENSIONAL FINITE ELEMENT GROUNDWATER MODEL FOR THE RIVER RHINE RESERVOIR KEHL/STRASBOURG.
Lahmeyer International G.m.b.H., Frankfurt am Main (Germany, F.R.).
For primary bibliographic entry see Field 7C.
W90-02995

ALTERNATING DIRECTION GALERKIN METHOD COMBINED WITH CHARACTERISTIC TECHNIQUE FOR MODELLING OF SATURATED-UNSATURATED SOLUTE TRANSPORT.
Fuzhou Univ. (China). Dept. of Geology and Mining Engineering.
K.-L. Huang.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 115-120, 3 fig, 7 ref.

Descriptors: *Mathematical models, *Model studies, *Path of pollutants, *Galerkin method, *Groundwater movement, *Solute transport, *Groundwater pollution, Path of pollutants, Porous media, Simulation, Numerical analysis, Performance evaluation, Alternating-direction Galerkin method, Comparison studies.

An alternating-direction Galerkin method combined with a characteristic method (ADCG) was developed for simulation of saturated-unsaturated solute transport in porous media. The aim of the method is to overcome numerical diffusion and oscillation and to ensure high accuracy and efficiency of computation. A novel characteristic method, base on single particle tracking of the front and high-order and linear interpolations near the front and the remaining paths of the domain, respectively, was developed to obtain the 'convective contribution.' The described ADCG method was employed with two example cases: (1) an idealized aquifer contamination problem with unidirectional flow of constant velocity and (2) a saturated-unsaturated transport experiment on partially ponding wastewater (20 g/l NaCl solution) disposal into loam with aggregated structure in a perspex slab 3 m in length, 2 m in height, and 0.3 m in thickness under drainage conditions in which the water table depth was initially 1.3 m. From these tests it is evident that ADCG, with the incorporated characteristic method, is superior to ADG in eliminating numerical difficulties and ensuring high accuracy and efficiency due to the allowable wider ranges of Peclet and Courant numbers. Furthermore, the improved characteristic method greatly simplifies its application in the hyperbolic problem and leads to more practical uses of the Eulerian-Lagrangian approach for the simulation of general transport problems. (See also W90-02980) (Rochester-PTT)
W90-02996

FINITE-ELEMENT ANALYSIS OF THE TRANSPORT OF WATER, HEAT AND SOLUTES IN FROZEN SATURATED-UNSATURATED SOILS WITH SELF-IMPOSED BOUNDARY CONDITIONS.
Quebec Univ., Sainte-Foy.
For primary bibliographic entry see Field 2C.
W90-02997

VARIABLY SATURATED FINITE-ELEMENT MODEL FOR HILLSLOPE INVESTIGATIONS.
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
For primary bibliographic entry see Field 2E.
W90-02998

SUBREGION BLOCK ITERATION TO 3-D FINITE ELEMENT MODELING OF SUBSURFACE FLOW.
Oak Ridge National Lab., TN. Environmental Sciences Div.
G. T. Yeh.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference

on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 133-138, 2 fig, 5 ref.

Descriptors: *Hydrologic models, *Storm seepage, *Finite element method, *Groundwater movement, *Model studies, Computer models, Performance evaluation, Saturated flow, Unsaturated flow, Subregion block iteration technique, Mathematical equations, Performance evaluation.

A subregion block iteration (SBI) technique was developed in conjunction with finite-element approximations of saturated-unsaturated flow equations. The proposed SBI technique was implemented in a three-dimensional finite-element saturated-unsaturated flow model. The model was verified with a nonlinear diffusion equation having an analytical solution. It was then applied to a typical single trench burial trench problem. This problem could not be solved using the direct elimination finite-element method. The SBI technique provides significant improvement over models based on direct band solution methods in both CPU storage (about 85%) and CPU time. Operational count indicates that the CPU time is proportional to the square of the matrix band-width. Thus, the CPU time with SBI would have been only approximately equal to (25/339) squared x 27, which equals 0.11 times that of the direct solution method for the example used here. (See also W90-02980) (Author's abstract)
W90-02999

DECOUPLED APPROACH TO THE SIMULATION OF FLOW AND TRANSPORT OF NON-AQUEOUS ORGANIC PHASE CONTAMINANTS THROUGH POROUS MEDIA.
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-03001

TRANSITION POTENTIALS DEFINING THE FLOW BOUNDARIES IN MULTIPHASE POROUS MEDIA FLOW.
SIMULTEC A.G., Zurich (Switzerland).
H. O. Schiegg.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 153-163, 2 fig, 2 ref.

Descriptors: *Groundwater movement, *Hydrodynamics, *Mathematical studies, *Multiphase flow, *Path of pollutants, *Boundaries, *Porous media, Hysteresis, Transition potential, Mathematical equations, Capillarity.

The transition potential is the fluid potential for the transition between fluid-dynamic existence of a fluid (funicular saturation) and its non-existence (residual saturation). The locus of such a transition defines a solution-dependent boundary. This boundary condition is considered here two-fluid flow and multiphase flow. Relevant equations and parameters for two and three non-mixing fluids (water and oil in quartz) are presented and discussed. The hysteresis rhomboid and its employment of the analysis of capillarity in the system are discussed. (See also W90-02980) (Rochester-PTT)
W90-03002

ENHANCED PERCOLATION MODEL FOR THE CAPILLARY PRESSURE-SATURATION RELATION.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2G.
W90-03003

SOLVING STOCHASTIC GROUNDWATER PROBLEMS USING SENSITIVITY THEORY

AND HERMITE INTERPOLATING POLYNOMIALS.
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
D. P. Ahlfield, and G. F. Pinder.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 179-184, 3 fig, 1 tab, 7 ref.

Descriptors: *Stochastic hydrology, *Path of pollutants, *Model studies, *Stochastic hydrology, *Groundwater movement, *Solute transport, Hermite polynomials, Hydraulic conductivity, Aquifers, Computer programs, Comparison studies, Monte Carlo method, Stochastic methods, Sensitivity analysis, Mathematical analysis, Cost analysis.

Equations for groundwater flow and convective-dispersive transport are solved for the distribution of concentration when a distribution of hydraulic conductivity is given. The methodology used approximates the function used to relate the conductivity and the concentration using a limited form of stratified sampling of the parameter distribution and interpolation of those sampling results using first order sensitivity information and Hermite polynomial interpolators. Use of the present approach to solving stochastic groundwater problems is illustrated using a hypothetical aquifer of the following properties: 50 ft thickness, 50 ft longitudinal dispersivity, 10 ft transverse dispersivity, 0.2 porosity, diffusion coefficient 0.0001 sq ft/day, 180 nodes, space discretization of 100-200 ft, and time step for mass transport of 10.5 days. In this system the conductivity is lognormally distributed. In this example, an exact duplication of the concentration distribution required only 11 nodes (at a cost of roughly 22 simulations), whereas over 500 simulations were needed to converge the distribution using the conventional Monte Carlo approach. Thus, the proposed method presents the opportunity for significant computational savings, in the present case, about a 20-fold improvement in the cost of computing the distribution. (See also W90-02980) (Rochester-PTT)
W90-03005

SUPERCOMPUTER SIMULATIONS OF HETEROGENEOUS HILLSLOPES.
Lancaster Univ. (England). Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2E.
W90-03006

COMPARISON OF NUMERICAL SOLUTION TECHNIQUES FOR THE STOCHASTIC ANALYSIS OF NONSTATIONARY, TRANSIENT, SUBSURFACE MASS TRANSPORT.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
W. Graham, and D. McLaughlin.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 191-196, 4 fig, 1 tab, 4 ref. NSF Grant ECE-8

Descriptors: *Model studies, *Path of pollutants, *Groundwater movement, *Numerical analysis, *Stochastic hydrology, *Solute transport, *Porous media, Computers, Advection, Dispersion, Differential equations, Finite element method, Galerkin method, Algorithms, Monte Carlo method, Principal direction algorithm, Performance evaluation, Comparison studies.

Stochastic methods were applied to the analysis and prediction of large-scale solute transport in saturated heterogeneous porous media. A set of coupled partial differential equations describing the

propagation of the concentration mean and covariance was derived from the classical advection-dispersion equation. It was assumed that the major factor contributing to uncertainty in the prediction of mass transport is the unknown spatial distribution of the underlying steady-state groundwater velocity field. Both an iterative principal direction finite element algorithm and an iterative conventional Galerkin finite element algorithm were developed to solve the equations. The performance of these solution algorithms was verified by Monte Carlo simulation and the accuracy, efficiency, and computer storage requirements of the three solution techniques are contrasted here. The perturbation has the obvious disadvantage that it is applicable only to random fields in which perturbations around the mean solution are relatively small. The perturbation method has the advantage that the solution grid need only be designed to capture the details of the moments of the random fields, rather than the variation of the random fields themselves. Thus, a covariance solution grid will typically require fewer nodes than a Monte Carlo solution grid. The principal direction algorithm is less accurate than the finite-element algorithm for problems with uniform mean flow fields and relatively large dispersivities. However, the principal direction covariance algorithm requires less computer storage and runs faster given the same solution grid, particularly as the number of nodes increases. The principal direction solution technique is thus best suited for large-scale problems with small transverse dispersivity. (See also W90-02980) (Rochester-PTT)
W90-03007

MODELLING FLOW IN HETEROGENEOUS AQUIFERS: IDENTIFICATION OF THE IMPORTANT SCALES OF VARIABILITY.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
L. R. Townley.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 197-202, 4 fig, 7 ref.

Descriptors: *Model studies, *Hydrologic models, *Groundwater movement, *Transmissivity, *Aquifers, Simulation, Scale, Mathematical models, Finite element method, Heterogeneity, Spatial variation, Numerical analysis, Covariance.

Although the spatial distribution of transmissivity in real aquifers is highly variable, adequate simulation often is achieved using spatially averaged transmissivity for model input. A fundamental question concerns the choice of the largest suitable averaging scale at which adequate simulation is achieved, but above which, prediction accuracy deteriorates. Prediction accuracy for a hypothetical aquifer is evaluated numerically using first-order calculations of the covariance of predicted heads. Uncertainty in transmissivity is represented by spatial covariance functions that take into account the length scales of averaging. The prediction of accuracy deteriorates when the averaging scale exceeds the correlation length of the underlying log transmissivity field. A complete solution to the problem as posed here will require further understanding of the relationship between: (1) the scale of the flow field; (2) the scale of variability of the underlying point process; (3) the scale with which spatial averaging is carried out; and (4) the scale of discretization with which an approximate finite-element solution is obtained. (See also W90-02980) (Rochester-PTT)
W90-03008

MODELLING OF SEA WATER INTRUSION OF LAYERED COASTAL AQUIFER.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
A. Das Gupta, and N. Sivanathan.
IN: Computational Methods in Water Resources:

Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 205-210, 4 fig, 7 ref.

Descriptors: *Model studies, *Groundwater movement, *Coastal aquifers, *Solute transport, *Saline water intrusion, Finite difference methods, Slopes, Leakage, Confined aquifers, Leaky aquifers, Mathematical models.

The effect of concentration on solute transport is considered in the analysis of a sea water intrusion problem in a two-layered surface aquifer system. An iterative solution scheme was employed to solve the flow and transport equations simultaneously by using implicit finite-difference approximation of the equation. Analysis with a coupled flow and transport model considering the effect of salt concentration on fluid properties indicates that for the sea water intrusion problem with source concentration normally in the range of 25-30 g/l, the effect of concentration change in viscosity is not significant. For area transport analysis, the slope of the aquifer bed introduces appreciable effect on concentration distribution as the flow velocity becomes significantly concentration dependent. Analysis with hypothetical but typical field problems indicates the effect of vertical leakage for a two-layered aquifer system on concentration distribution. Leakage from unconfined aquifer to confined aquifer results in reduction of the level of concentration in the unconfined aquifer. With influx to the confined aquifer, the piezometric level drop due to pumping is less compared to the case where there is no leakage. As a result, the level of concentration with time at a particular point is low compared to that for a fully-confined situation. With an increase in K' value, further reduction is expected. (See also W90-02980) (Rochester-PTT) W90-03009

COMPARISON OF COUPLED FRESHWATER-SALTWATER SHARP-INTERFACE AND CONVECTIVE-DISPERSIVE MODELS OF SALTWATER INTRUSION IN A LAYERED AQUIFER SYSTEM.
Geological Survey, Lakewood, CO.
M. C. Hill.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 211-216, 2 fig, 5 ref.

Descriptors: *Coastal aquifers, *Solute transport, *Saline water intrusion, *Saline-freshwater interfaces, *Aquifer system, *Groundwater movement, *Simulation, *Convection, *Dispersion, *Mathematical models, SUTRA model, Confined aquifers, Leaky aquifers, Density, Path of pollutants, Comparison studies, Numerical analysis.

Simulated results of the coupled freshwater-saltwater sharp-interface (FSSI) and convective-dispersive numerical models are compared using steady-state cross-sectional simulations. The coupled FSSI model solves continuity equations for the fresh and saltwater regions of a simulated aquifer system. The sharp interface that separates the two regions is located so that the hydraulic pressures on each side of the interface are equal and the continuity of pressure in the system is maintained. The model is quasi-three dimensional in that only horizontal flow is simulated within aquifer layers and only vertical flow is simulated between aquifer layers. The finite-difference method is used to discretize the simulated system. The two-dimensional, convective-dispersive model used here is commonly known as SUTRA (Saturated-Unsaturated TRansport). The model solves continuity and transport equations in which pressure and solute mass fraction are the dependent variables, and fluid density depends on solute mass fraction. The model can simulate flow and transport in two dimensions. In the present work, simu-

lated solute mass fractions are presented as isochlors (lines of equal chloride concentration relative to seawater, i.e., the 1.0 isochlor represents seawater, the 0.0 isochlor represents freshwater). The finite-element method is used to discretize the simulated area or cross section. The two methods used produced nearly identical flow rates in much of the freshwater part of the system and would, therefore, produce similar calculated travel times for use in studies of groundwater flow. The calculated sharp interface commonly was landward of even the 0.2 isochlor in two of the aquifers, indicating that, for the conditions employed, the FSSI model may produce an estimate of the location of saltwater in coastal aquifers that is further landward than that produced by the convective-dispersive model. It is hypothesized that this is due to how vertical flow through confining beds is represented in the sharp-interface model. (See also W90-02980) (Rochester-PTT) W90-03010

CAN THE SHARP INTERFACE SALT-WATER MODEL CAPTURE TRANSIENT BEHAVIOR.
Princeton Univ., NJ. Dept. of Civil Engineering.
G. Pinder, and S. Stothoff.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 217-222, 5 fig, 1 tab, 3 ref.

Descriptors: *Saline-freshwater interfaces, *Model studies, *Hydraulic transients, *Groundwater movement, *Coastal aquifers, *Solute transport, *Saline water intrusion, Vertical flow, Simulation, Boundaries, Pumping, Mathematical models, Path of pollutants, Comparison studies.

The formal simulation of groundwater flow in coastal aquifers encountering salt water should employ the three-dimensional flow and transport equations, but the reduction of this problem to two spatial dimensions in the areal plane, using a sharp-interface assumption, often has been employed to render field problems tractable. The transient sharp-interface areal two-dimensional formulation and the three-dimensional solute transport formulation were compared, and an example of divergence between the two approaches is presented. It was hypothesized that the interface does not respond to a stress causing vertical fluid gradients in a manner consistent with the dynamic movement of the saltwater/fresh-water front. To test this hypothesis, salt-water upconing beneath a pumping well was simulated using both the transport equations (in cylindrical coordinates) and the sharp-interface equations defined in the areal plane. In both cases, the system was initially in hydrostatic equilibrium, and the outside boundary remained so through first-type conditions. The remaining boundaries are no-flux boundaries, except at the well. In response to the pumping stress, the interface moves vertically upward. The movement of the interface as simulated by the two models was entirely different. The assumptions inherent in the vertically-integrated, sharp-interface formulation, while at first glance quite reasonable, in fact lead to equations that fail to accurately capture the dynamics of the saltwater/fresh-water interface for the test problem. By extension, it is concluded that the two-dimensional sharp-interface formulation does not account adequately for the transient behavior of regimes exhibiting significant vertical flow. (See also W90-02980) (Rochester-PTT) W90-03011

STABILITY ANALYSIS OF DISCRETE APPROXIMATIONS OF THE ADVECTION-DIFFUSION EQUATION THROUGH THE USE OF AN ORDINARY DIFFERENTIAL EQUATION ANALOGY.
Mexican Inst. of Water Technology, Jiutepec.
A. A. Aldama.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 3-

8, 2 fig, 8 ref.

Descriptors: *Path of pollutants, *Mathematical studies, *Approximation method, *Solute transport, *Groundwater movement, Mathematical equations, Finite difference methods, Spatial distribution, Stability analysis.

The existence of an analogy between stability properties of numerical integration schemes of an ordinary differential equation (dy/dt = lambda y) and those of finite difference approximations of the advection-diffusion equation is shown, and applied to simplify the stability analysis of the advection-diffusion equation. This is illustrated here by determination of the stability curves for the Adams-Bashforth scheme, combined with various spatial discretizations, which shows that the proposed analogy between the two types of equations permits the determination of practical stability criteria, even in cases where the complexity of the expressions resulting from the classical stability analysis technique makes those criteria difficult to obtain. (See also W90-03036) (Rochester-PTT) W90-03037

SOLUTION OF THE ADVECTION-DIFFUSION EQUATION USING THE TOTAL DERIVATIVE AND LEAST SQUARES COLLOCATION.
Princeton Univ., NJ. Dept. of Civil Engineering.
L. R. Bentley, G. F. Pinder, and I. Herrera.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 9-14, 2 fig, 5 ref.

Descriptors: *Mathematical studies, *Groundwater movement, *Solute transport, *Least squares method, Mathematical equations, Advection-diffusion equation, Performance evaluation, Eulerian-Lagrangian methods, Spatial distribution.

Many workers have turned recently to Eulerian-Lagrangian methods (ELM) in an attempt to capture satisfactorily both the second order parabolic and first order nature of the advection-diffusion transport equation. A method is presented here resembles an ELM in that information required in the difference equations is brought from the last time step by tracking along coordinates. The advection-diffusion equation is written in Lagrangian coordinates. It is then approximated by a central difference in time and a least-squares collocation (LESCO) discretization in space. The collocation point locations are projected backward along characteristics. A major difference between the present approach and ELMs is that no intermediate solution is computed. Excellent results have been obtained using the total derivative and LESCO to solve the advection-diffusion transport equation. Two examples computed here show that the method works well in advection-dominated transport. This is due partially to having eliminated the first order hyperbolic term that dominates when the Peclet number is too large. As the velocity decreases, the equations reduce to Eulerian equations for diffusion, so the procedure works well for diffusion-dominated transport as well. (See also W90-03036) (Rochester-PTT) W90-03038

ANALYSIS OF SOME CLASSES OF PETROV-GALERKIN AND OPTIMAL TEST FUNCTION METHODS.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
E. T. Bouloutas, and M. A. Celia.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 15-20, 2 fig, 8 ref.

Descriptors: *Mathematical studies, *Galerkin method, *Advection, *Groundwater movment, *Petrov-Galerkin methods, Optimal test functions, Mathematical equations, Algorithms, Time series analysis, Mathematical models.

Systematic development and analysis was conducted on some of the Petrov-Galerkin (PG) and Opti-

mal Test Function (OTF) methods employed in obtaining reliable numerical solutions to advection-dominated flow problems. It is shown that, for model one-dimensional steady state and transient advection-diffusion problems, these diverse formulations produce similar, in some cases identical, results. The methods considered were Allen and Southwell difference scheme, quadratic PG, streamline upwind PG, exponential PG, and OTF methods. The method for generalizing these methodologies to time-dependent problems is presented. (See also W90-03036) (Rochester-PTT)
W90-03039

CELL ANALYTIC-NUMERICAL METHOD FOR SOLUTION OF THE TWO-DIMENSIONAL ADVECTION-DISPERSION EQUATION.
Illinois Univ. at Urbana-Champaign. Dept. of Nuclear Engineering.
O. A. Elnawawy, A. J. Valocchi, and A. M. Ougouag.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 21-26, 2 fig, 4 ref. NSF Grant ECE 84-18644 and USGS Grant 14-08-001-G1299.

Descriptors: *Mathematical studies, *Advection, *Dispersion, *Numerical analysis, *Groundwater movement, Algorithms, Cell Analytic-Numerical Method, Advection, Dispersion, Mathematical equations, Performance evaluation, Grid orientation error, Comparison studies.

A numerical method, called the Cell Analytic-Numerical (CAN) Method, has been developed for solution of the two-dimensional advection-dispersion equation by using a transverse integration technique followed by analytical solution of the transverse-integrated local equations. Continuity of the mass flux is then used to obtain a set of coupled tridiagonal equations, which can be solved efficiently. This new method is demonstrated to have high accuracy, even when applied on coarse meshes, and to have minimal grid orientation error. The example problem involved an instantaneous contaminant point source in an infinite homogeneous domain. The results are compared with an available analytical solution and with another numerical solution obtained by the Alternating Direction Galerkin (ADG) technique. The CAN method is more accurate than the ADG method and is free from grid orientation error. (See also W90-03036) (Rochester-PTT)
W90-03040

FINITE ELEMENT TECHNIQUES FOR CONVECTIVE-DISPERSIVE TRANSPORT IN POROUS MEDIA.
Wyoming Univ., Laramie. Dept. of Mathematics.
R. E. Ewing.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 27-34, 17 ref.

Descriptors: *Mathematical studies, *Path of pollutants, *Convection, *Dispersion, *Diffusion, *Groundwater movement, *Solute transport, *Porous media, *Galerkin method, *Finite element method, Spatial distribution, Method of characteristics, Mathematical equations.

Operator-splitting techniques are applied to convective-diffusive transport problems in porous media. The convection is treated by applying a modified method of characteristics to time-step along the characteristics of the convective-part of the flow. The non-symmetry in the spatial operator is addressed via a Petrov-Galerkin method that uses a test function to achieve stability through a balancing of the remaining convection, the diffusion, and any possible reaction terms. The use of time-stepping along characteristics allows the use of large time-steps in a stable but accurate fashion. If local phenomena are important, self-adaptive local grid refinement techniques can be coupled with the operator splitting. (See also W90-03036) (Author's abstract)
W90-03041

3-D FINITE ELEMENT TRANSPORT MODELS BY UPWIND PRECONDITIONED CONJUGATE GRADIENTS.
Padua Univ. (Italy). Inst. of Applied Mathematics.
For primary bibliographic entry see Field 5B.
W90-03042

STRUCTURE OF MASS-RESPONSE FUNCTIONS OF DISSOLVED SPECIES IN HYDROLOGIC TRANSPORT VOLUMES.
Trento Univ. (Italy). Dept. of Engineering.
For primary bibliographic entry see Field 5B.
W90-03043

ADVECTION CONTROL METHOD FOR THE SOLUTION OF ADVECTION-DISPERSION EQUATIONS.
Shandong Univ., Jinan (China).
N.-Z. Sun, and W.-K. Liang.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 51-56, 2 fig, 9 ref.

Descriptors: *Mathematical studies, *Path of pollutants, *Solute transport, *Groundwater movement, *Numerical analysis, Mathematical equations, Advection, Dispersion, Upstream weighting methods, Method of characteristics, Moving point methods, Multiple cell balance method, Performance evaluation.

A variety of improved numerical methods has been presented recently to deal with numerical difficulties arising in the solution of advection-dominated transport problems. Examples are Upstream Weighting Methods (UWM), the Method of Characteristics (MOC), and Moving Point Methods. The upstream weighted Multiple Cell Balance Method (MCBM) of Sun and Yeh was modified to create the Advection Control Method (ACM), which is described here. The method differs from the MOC and UWM in that an advection control term is added onto the right-hand side of the discretized mass balance equation of each node to control the behavior of numerical solutions. One or several invented nodes are introduced into each element. The concentration of an invented node is considered as a weighted average of two parts, one determined by nodal values of real nodes and the other by a 'single-step reverse particle tracking' technique. The overshoot of numerical solutions can be eliminated and the numerical dispersion is smaller than that of UWMs, and the boundary conditions and sink or source terms can be treated as in the finite-element methods. The method is applied easily to three-dimensional field problems, but there remains an undefined coefficient that needs to be designated artificially. (See also W90-03036) (Rochester-PTT)
W90-03044

NON-DIFFUSIVE N+2 DEGREE UPWINDING METHODS FOR THE FINITE ELEMENT SOLUTION OF THE TIME DEPENDENT TRANSPORT EQUATION.
Texas A and M Univ., College Station. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-03045

CHARACTERISTIC ALTERNATING DIRECTION IMPLICIT SCHEME FOR THE ADVECTION-DISPERSION EQUATION.
Nanjing Univ. (China). Dept. of Geology.
Y. Xue, and C. Xie.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 63-68, 4 fig, 2 ref, append.

Descriptors: *Mathematical studies, *Path of pollutants, *Groundwater movement, *Solute transport, *Heat transfer, *Convection, *Diffusion, Aquifers, Numerical analysis, Performance evaluation.

A new method for the numerical solution of the convection diffusion equation in one, two, and three dimensions is presented. This numerical scheme is based on combining the utility of a fixed grid in Eulerian coordinates with the computation power of the Lagrangian method. A detailed comparison is made of simulated concentrations with analytical solutions, including an analytical solution of the three-dimensional advection-dispersion equation. The numerical method is employed with some solute transport and heat transfer problems. The numerical results demonstrate that the method is capable of solving advection-dispersion problems without generating significant numerical diffusion when Peclet number is not too large and oscillations are absent. Numerical diffusion is caused mainly by the interpolation between nodes. Due to increases in interpolation and computation, the results of two-dimensional and three-dimensional problems are not as good as those for one-dimensional problems. (See also W90-03036) (Rochester-PTT)
W90-03046

ZOOMABLE AND ADAPTABLE HIDDEN FINE-MESH APPROACH TO SOLVING ADVECTION-DISPERSION EQUATIONS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
G. Y. Yeh.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 69-74, 2 fig, 5 ref.

Descriptors: *Mathematical studies, *Path of pollutants, *Solute transport, *Mathematical equations, *Groundwater movement, *Finite element method, *Advection, *Dispersion, Numerical analysis, Algorithms, Mathematical models, Finite difference methods, Performance evaluation.

A zoomable and adaptable hidden fine-mesh approach (ZAHFMA), which can be used with either finite element or finite difference methods, is proposed to solve the advection-dispersion equation. The approach is based on automatic adaptation of zooming a hidden fine-mesh in the place where the sharp front locates. Preliminary results indicate that ZAHFMA used with finite element methods can handle the advection-dispersion problems with Peclet number ranging from zero to infinity. The application discussed here is one-dimensional transient transport from an upstream concentration in cases of pure dispersion with Peclet number of 0 and of dispersion equal to 0 and Peclet number equal to infinity. For the first of these examples, ZAHFMA yields results very close to the analytical solution whether the hidden nodes are 0, 1, or 3. In the second case, numerical dispersion is greatly reduced with 9 hidden nodes per element. Thus, the number of hidden nodes per element required to reduced numerical dispersion to an acceptable level depends on the nature of the problem. (See also W90-03036) (Rochester-PTT)
W90-03047

ADVANCES ON THE NUMERICAL SIMULATION OF STEEP FRONTS.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Geofisica.
I. Herrera, and G. Hernandez.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 139-145, 3 fig, 10 ref.

Descriptors: *Mathematical models, *Path of pollutants, *Numerical analysis, *Groundwater movement, *Solute transport, Advection, Finite element method, Petrov-Galerkin methods, Test functions, Performance evaluation, Comparison studies, Mathematical equation, Precision.

Solution of advection-dominated transport problems by discrete interior methods usually is accomplished by employing some type of upstream weighting. Upwinded finite-element formulations also have been developed. These usually are based on Petrov-Galerkin formulations. More recently, a procedure has been proposed that produces optimal test functions (OTFs) using approximate solu-

tions to the adjoint equation. Advantages of this method are: (1) no arbitrary parameters appear in their definitions; (2) the functions vary continuously with the coefficients of the equations; (3) the definition of weighting functions results from a systematic and mathematically sound formulation; and (4) rapidly convergent and accurate solutions are obtained. The test functions resulting from the new procedure were compared with those of the Hughes and Brooks procedure. The results obtained in advection-dominated problems using semi-discretization were quite satisfactory, being largely oscillation free. The only method providing results close for a large number of Peclet numbers was the Petrov-Galerkin version of Hughes and Brooks (HB). This is because of the similarity of the weighting functions used in two methods. With the OTF procedure, it is possible to produce solutions with any desired order of accuracy, something that is not possible with the HB procedure. (See also W90-03036) (Rochester-PTT)
W90-03056

GUIDELINES FOR THE USE OF PRECONDITIONED CONJUGATE GRADIENTS IN SOLVING DISCRETIZED POTENTIAL FLOW PROBLEMS.
Dienst Grondwaterverkenning TNO, Delft (Netherlands).
E. F. Kaasschieter.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 147-152, 12 ref.

Descriptors: *Mathematical models, *Computers, *Groundwater movement, *Saturated flow, Mathematical equations, Porous media, Mathematical models, Computers.

In the last decade, interest has grown in the preconditioned conjugate gradient (CG) method as a successful iterative approach to solving systems of linear equations involving a large, sparse, and symmetric positive definite coefficient matrix. The method is particularly suitable for modelling stationary groundwater flow in a saturated porous medium. However, to achieve optimal convergence for the preconditioned CG method in practical modelling, it is necessary to have some insight into the most important aspects of the CG method. The nature of the potential flow problem is summarized and the properties characterizing the CG method are reviewed, including a discussion of the derivation of a practical termination criterion and a particularly preconditioning, the well-known incomplete Cholesky decomposition. The CG method is very attractive for solving discretized potential flow problems because it is reliable and, when preconditioned, is generally fast. Its memory space requirements are modest and it is easy to implement. Moreover, a safe termination criterion based on the interaction constants can be used. (See also W90-03036) (Rochester-PTT)
W90-03057

THREE-DIMENSIONAL ADAPTIVE EULERIAN-LAGRANGIAN FINITE ELEMENT METHOD FOR ADVECTION-DISPERSION.
Nebraska Univ., Lincoln. Conservation and Survey Div.
R. Cady, and S. P. Neuman.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 183-193, 9 fig, 9 ref.

Descriptors: *Mathematical studies, *Path of pollutants, *Solute transport, *Groundwater movement, *Hydraulic models, *Finite element method, Aquifers, Aquitards, Errors, Performance evaluation, Tracers, Waves, Eulerian-Lagrangian methods, Wells, Peclet number.

The adaptive Eulerian-Lagrangian finite-element method of Neuman has been improved and extended to three-dimensional domains. Accurate results have been obtained for the entire range of Peclet numbers from very small to infinity and Courant numbers at least up to 15. Difficulties resolved include oscillations, numerical smearing,

clipping of peaks, and grid orientation effects. Results are described and discussed for four examples: (1) the two-dimensional dispersion of a rectangular wave in a uniform velocity field over an infinite domain at relatively low Peclet numbers; (2) an example similar to (1), except that dispersion is reduced by an order of magnitude and v sub y is reduced from 400 to 300 so that Peclet numbers are larger Pe sub x of 100 vs. 10, Pe sub y of 120 vs 16; (3) a pair of injection and discharge wells in an extensive aquifer without background flow (based on a laboratory tracer experiment); and (4) a well injecting contaminated water into a 4 m-thick aquifer confined between two identical aquitards having a thickness of 50 m each. (See also W90-03036) (Rochester-PTT)
W90-03062

COMPUTER MODELING OF GROUNDWATER FLOW THROUGH POROUS MEDIA USING A MONTE-CARLO SIMULATION TECHNIQUE.
TGG Environmental, Inc., Needham, MA.
J. S. Loitherstein.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 195-200, 2 fig, 2 tab, 7 ref.

Descriptors: *Mathematical studies, *Dispersion, *Path of pollutants, *Groundwater movement, *Porous media, *Simulation, *Advection, *Plumes, Hydrodynamics, Monte Carlo method, Mathematical models, Statistics, Computers, Graphics.

A computer model is discussed for simulating the movement of groundwater through porous media. The movement is simulated in terms of its two components: advection and hydrodynamic dispersion. Advection is a purely translational movement directly related to the magnitude and direction of the groundwater velocity. The movement of the groundwater due to dispersion is too complex to analyze numerically. Instead it is modelled using a Monte-Carlo simulation technique. This permits calibrating the dispersion component by varying the statistical parameters in the model. It was shown that the random numbers had a major effect on the groundwater plume. Although this can be induced by varying the longitudinal and transverse dispersivities, the random number distribution adds another degree of sensitivity. The following specific observations were made: (1) the shape and extent of the plume is sensitive to manipulation of the random numbers used to simulate the dispersion; (2) the particle cloud method of presenting the data is more discernible than a group of lines showing the paths of the particles and color graphics enhance the results; and (3) two types of parameters are input into the code, those related to groundwater movement and those related to graphic presentation of the data; the graphics parameters are determined somewhat by the aquifer parameters, for example, using fewer particles with a simulation involving a small longitudinal or transverse dispersivity. The advantage of using fewer particles is that it reduces the amount of time required to perform each simulation. (See also W90-03036) (Rochester-PTT)
W90-03063

DISPERSION OF CONTAMINANTS IN SATURATED POROUS MEDIA: VALIDATION OF A FINITE-ELEMENT MODEL.
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
For primary bibliographic entry see Field 5B.
W90-03064

MODELING WATER AND CONTAMINANT TRANSPORT IN UNCONFINED AQUIFERS.
Australian Nuclear Science and Technology Organisation, Sutherland. Environmental Science Div.
For primary bibliographic entry see Field 5B.
W90-03065

ACCURATE FINE-GRID SIMULATIONS TO DERIVE COARSE-GRID MODELS OF FINE-

SCALE HETEROGENEITIES IN POROUS MEDIA.
Colorado Univ. at Denver. Dept. of Mathematics.
T. F. Russell.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 213-218, 18 ref.

Descriptors: *Mathematical studies, *Model studies, *Dispersion, *Path of pollutants, *Porous media, *Finite element method, *Groundwater movement, *Solute transport, Plumes, Numerical analysis, Galerkin Method, Viscosity, Errors.

In the context of a model of miscible transport in a porous medium, a Galerkin modified method of characteristics and a mixed finite-element method are introduced. Previous theoretical and numerical studies demonstrating the accuracy of these methods are summarized and future studies are outlined. Unstable fronts, which occur when a fluid is displaced by another fluid of lower viscosity, are emphasized. In this situation, averaging should account for fluid properties as well as rock properties. Numerical studies have yielded very accurate results. As expected theoretically, meshes can be coarser than those of standard methods and the time steps can be 1-2 orders of magnitude larger. For high-mobility-ratio problems with severe tendencies toward viscous fingering, answers converge as grids and time steps are refined. For homogeneous media with finite dispersion, the answers converge to stable unfingered fronts, as they should; dispersion prevents the growth of short-wavelength disturbances arising from small numerical errors. For slightly heterogeneous media, answers converge to fingered fronts; homogeneous tests show that these results reflect physical fingering and not the effects of numerical errors. (See also W90-03036) (Rochester-PTT)
W90-03066

NUMERICAL EXPERIMENT WITH EULER-LAGRANGE METHOD FOR A PAIR OF RECHARGE-PUMPING WELLS.
Technion - Israel Inst. of Tech., Haifa. Faculty of Bio-Medical Engineering.
For primary bibliographic entry see Field 5B.
W90-03067

USE OF PARTICLE TRACKING METHODS FOR SOLUTE TRANSPORT IN POROUS MEDIA.
Lawrence Livermore National Lab., CA. Earth Sciences Dept.
For primary bibliographic entry see Field 5B.
W90-03068

MASS EXCHANGE BETWEEN MOBILE FRESH WATER AND IMMOBILE SALINE WATER IN THE UNSATURATED ZONE.
Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.
For primary bibliographic entry see Field 2G.
W90-03069

SOLUTION OF SATURATED-UNSATURATED FLOW BY FINITE ELEMENT OR FINITE DIFFERENCE METHODS COMBINED WITH CHARACTERISTIC TECHNIQUE.
Fuzhou Geological Coll. (China).
K. L. Huang.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 241-246, 4 fig, 7 ref.

Descriptors: *Mathematical studies, *Path of pollutants, *Saturated flow, *Unsaturated flow, *Groundwater movement, *Finite element method, *Finite difference methods, Method of characteristics, Mathematical equations, Simulation, Irrigation, Evaporation, Numerical analysis, Performance evaluation.

Besides the high nonlinearity, the hyperbolic features of the flow equation due to a predominantly

gravitational term is another important factor leading to the numerical oscillation and diffusion in the simulation of vertically saturated-unsaturated flow problems. Two schemes, the characteristic finite element (CFE) and characteristic alternating direction difference (ADCI), are developed for one-dimensional and two-dimensional problems, respectively, to eliminate the numerical difficulties and to ensure high accuracy and efficiency. Examples are simulated to demonstrate the advantages of the proposed methods. These include: (1) a field experiment in irrigation under ponding in Panoch clay loam; (2) the same as example (1), but with rain occurring at an intensity of 37.8 cm/day (equal to soil permeability); and (3) an evaporation experiment in Ida soil performed in cylinders with a diameter of 7.5 cm and a height of 38 cm, under various intensities of illumination by bulbs. (See also W90-03036) (Rochester-PTT)
W90-03070

CHARACTERISTIC FINITE ELEMENT MODEL FOR SOLUTE TRANSPORT IN SATURATED-UNSATURATED SOIL.
Wuhan Inst. of Hydraulic and Electric Power Engineering (China). Dept. of Irrigation and Drainage.
For primary bibliographic entry see Field 5B.
W90-03072

CONFRONTATIONS BETWEEN COMPUTER SIMULATIONS AND LABORATORY WORK TO UNDERSTAND MECHANISMS CONTROLLING TRANSPORT OF MERCURY.
Strasbourg-1 Univ. (France). Inst. de Mechanique des Fluides.
For primary bibliographic entry see Field 5B.
W90-03074

QUICK ALGORITHM FOR THE DEAD-END PORE CONCEPT FOR MODELING LARGE-SCALE PROPAGATION PROCESSES IN GROUNDWATER.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
For primary bibliographic entry see Field 5B.
W90-03075

SIMULATION OF GROUNDWATER TRANSPORT TAKING INTO ACCOUNT THERMODYNAMICAL REACTIONS.
Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl fuer Hydrogeologie und Hydrochemie.
For primary bibliographic entry see Field 5B.
W90-03076

MULTICOMPONENT SOLUTE TRANSPORT WITH MOVING PRECIPITATION/DISSOLUTION BOUNDARIES.
Notre Dame Univ., IN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-03077

ADVANTAGE OF HIGH-ORDER BASIS FUNCTIONS FOR MODELING MULTICOMPONENT SORPTION KINETICS.
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 5D.
W90-03078

FINITE ELEMENT MODEL OF FREE CONVECTION IN GEOLOGICAL POROUS STRUCTURES.
LEPT-ENSAM, Esplanade des Arts et Metiers, 33405 Jalence, France.
D. Bernard.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 301-306, 3 fig, 1 tab, 8 ref.

Descriptors: *Model studies, *North Sea, *Oil fields, *Finite element method, *Groundwater movement, *Aquifers, *Computer models, Porous media, Simulation, Performance evaluation, DBCONV5 model, Convection, Diagenesis, Oil.

Free convection is a common phenomenon in porous rocks. Precise study of processes such as mineral diagenesis or petroleum generation requires estimates of the possible convective flow patterns, of the related thermal perturbation and of the induced fluid velocity field. With this in mind, the finite element model DBCONV5 was developed around the general finite element program package MODULEF (Inria, France). The numerical aspects of the model are presented here and two recent applications are described to illustrate the possibilities of this model. The first example is a real case (Alwyn field, North Sea) for which preliminary results are given. The second example is a case of a sloped layer limited by impervious conducting strata, which is considered in more detail. Various flow patterns were identified for different values of the filtration Rayleigh number and the ratio of the thermal conductivities of the porous and impervious layers. The modular organization of the DBCONV5 model makes it easier to extend its capabilities (e.g., 3-dimensional flow, time-varying transport) or couple it with other simulators (e.g., geochemical, mechanical). (See also W90-03036) (Rochester-PTT)
W90-03079

RADIATIVE HEAT TRANSFER TO FLOW IN POROUS PIPE WITH CHEMICAL REACTION AND LINEAR AXIAL TEMPERATURE VARIATION.
International Centre for Theoretical Physics, Trieste (Italy).
For primary bibliographic entry see Field 8B.
W90-03080

VALIDATION OF FINITE ELEMENT SIMULATION OF THE HYDROTHERMAL BEHAVIOR OF AN ARTIFICIAL AQUIFER AGAINST FIELD PERFORMANCE.
Technische Hochschule Aachen (Germany, F.R.). Inst. fuer Wasserbau.
H. Daniels.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 319-324, 5 fig, 6 ref.

Descriptors: *Model studies, *Aquifers, *Hydrothermal studies, *Thermal power, *Hydraulic models, *Finite element method, West Germany, Convection, Temperature, Navier-Stokes equations, Mathematical models, Pressure.

The effect of natural convection and density-driven flow is of major importance to the flow field and the temperature field in the artificial aquifer for thermal energy storage that has been built at Stuttgart University (West Germany). A finite-element approximation was used to calculate the transient temperature field in the aquifer; validation was conducted against data from field experiments. Permeability and temperature differences are very high at the Stuttgart aquifer test site. The temperature field can be calculated accurately using equilateral triangles. A hybrid formulation was obtained by substituting Darcy's law into the continuity equation to yield an alternative formulation of the pressure distribution. A quasi-Navier-Stokes formulation for the flow field equation may be advantageous compared to standard Darcy for natural convection in coarse gravel. (See also W90-03036) (Rochester-PTT)
W90-03082

NUMERICAL MODELING OF HOT WATER STORAGE IN AQUIFER BY FINITE ELEMENT METHOD.
Ecole Nationale Superieure d'Arts et Metiers, Paris (France).
B. Goyeau, J. Gounot, and P. Fabrie.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 325-330, 4 fig, 12 ref.

Descriptors: *Model studies, *Finite element method, *Hydrothermal studies, *Heat transfer, Simulation, Viscosity, Convection, Density, Hydrodynamics, Numerical analysis, Aquifer management, Mathematical models.

Natural convection problems were used to test the validity of a three-dimensional finite element method developed for the simulation of hot water storage in a stratified aquifer saturated by cold water. The coupling of Rayleigh-Benard and Saffman-Taylor instabilities was investigated during the storage in a homogeneous aquifer. The hydrodynamic instabilities of non-isothermal flow through porous media were investigated when both density and viscosity vary with temperature. The instabilities are due to a density gradient directed upward (Rayleigh-Benard instabilities), and to the displacement of a more viscous fluid by a less viscous one inducing fingering (Saffman-Taylor instabilities). The simulation aimed to identify the conditions for which the effects of hydrodynamic instabilities are minimized. The simulations were performed for cylindrical three-dimensional aquifers. The equations used to model the system were discretized using Q1 finite elements in space and an Euler's semi-implicit scheme in time. The matrix system was solved by the preconditioned conjugate gradient method. When the Rayleigh number is nearly zero, the flow is one-dimensional and isotherms are vertical. The hot fluid penetration into the cold fluid at the upper part of the layer is increased with decreasing velocity ratio and increasing Rayleigh and Peclet number. These phenomena may increase the heat transfer in the aquifer and drastically affect the efficiency of the storage. Accounting for viscosity variation was the main numerical difficulty in this problem. At each time step assembly had to be repeated and the global computation time was long. (See also W90-03036) (Rochester-PTT)
W90-03083

MODELLING THE REGIONAL HEAT BUDGET IN AQUIFERS.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie.
J. Trosch, and H. Muller.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 331-335, 1 fig, 2 ref.

Descriptors: *Model studies, *Heat budget, *Regional analysis, *Aquifer management, *Heat pumps, *Hydrothermal studies, Mathematical models, Energy flow, Advection, Heat transfer, Computer programs, Performance evaluation, Simulation.

An adequate model was needed for the management of groundwater that is employed in heat-pumping operations. The physical system is fully three-dimensional, with non-linear coupling of hydrodynamic and thermodynamic equations. To circumvent a three-dimensional treatment of regional aquifer problems, an interlace numerical model based on the finite element technique was developed. The vertical and horizontal directions were separated and discretized with one-dimensional and two-dimensional submodels. For the heat flux from the atmosphere through the confining layer and through the aquifer, one-dimensional vertical models were used. The flow and the advection of the energy in the aquifer were calculated using the well-established concept of two-dimensional horizontal models, where the unknowns are vertically integrated with the help of simplifying assumptions, such as the Dupuit assumption in flow calculations. The heat transport models first were tested separately and then compared with analytical solutions. The decoupling of the two-dimensional transport in the aquifer from the vertical heat conduction from the atmosphere to the aquifer gives good results for heat budget calculations. The execution time on a VAX 8600 for simulation of a whole year was about an hour. However, with the simplification made it was impossible to represent, for example, the near field of a cold water plume. (See also W90-03036) (Rochester-PTT)
W90-03084

THERMAL ENERGY STORAGE MODEL FOR A CONFINED AQUIFER.
Nanjing Univ. (China). Dept. of Geology.
Y. Xue, C. Xie, and Q. Li.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 337-342, 5 fig, 3 ref.

Descriptors: *Model studies, *Hydrothermal studies, *Confined aquifers, *Aquifer management, Mathematical models, Convection, Heat transfer, Wells, Temperature, China, Performance evaluation, Injection wells, Simulation.

A three-dimensional, convection-heat dispersion model is proposed for describing a series of aquifer thermal energy storage experiments in China. The model was applied to experimental data obtained from a test site in which there were 4 injection-production wells and 34 observation wells. The test aquifer is confined and consists of fine and medium sand to coarse sand with a few pebbles. Results are described for a multi-well experiment in which warm water was injected into two wells and cold water was extracted from two other wells. The simulated temperatures agreed well with the field data. Parameters obtained from the multiwell experiment can be extended to simulate the data obtained from a double well experiment at the same location. The model results are considered to be reasonable and dependable. (See also W90-03036) (Rochester-PTT)
W90-03085

NETWORK MODEL ASSESSMENT TO LEAKAGE OF FILL DAM.
Gifu Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-03089

GROUNDWATER MONITORING NETWORK DESIGN.
Wright State Univ., Dayton, OH. Dept. of Geology.
For primary bibliographic entry see Field 7A.
W90-03090

ADJOINT-STATE AND SENSITIVITY COEFFICIENT CALCULATION IN MULTILAYER AQUIFER SYSTEM.
Westinghouse Hanford Co., Richland, WA.
A. H. Lu, C. Wang, and W. W.-G. Yeh.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 377-384, 1 fig, 1 tab, 14 ref.

Descriptors: *Model studies, *Waste disposal, *Radioactive waste disposal, *Waste isolation, *Washington, *Groundwater movement, *Computer models, *Aquifers, Hydraulic conductivity, Hydraulic head, Computer programs, Mathematical models, Algorithms, Sensitivity analysis, Performance evaluation, Simulation, Columbia basalts.

A computational code employing the variational method was developed to calculate the sensitivity coefficients in a multilayer aquifer system (Columbia basalts, Washington). The sensitivity coefficients are defined as the derivative of the hydraulic head with respect to the hydraulic conductivities. Both the three-dimensional flow equations and the adjoint sensitivity equations are solved using a method that combines the local mass balance and finite element approximation. The code is designed for use as a module for parameter estimation by incorporating a generalized least-squares algorithm. The developed methodology is especially suitable for a large number of groundwater parameter estimations for which a limited number of measurements may exist. The computational advantage and applications of the developed code are discussed. The flow system in the Columbia basalts, comprising intact, thick basalt flow interiors of very low permeability interspaced by thin flow top layers of higher permeability, was conceptualized as a three-dimensional flow with uniform-thickness multilayer stratigraphic unit layers. The method proposed here was effective and efficient

for calculating the sensitivity coefficients. Advantages of the method are: (1) the sensitivity coefficient matrix can be calculated accurately by the method and (2) when the number of observation locations is less than the number of parameters, which is always the case, the proposed method will achieve computational efficiency. Large numerical integration over the time domain is required; the head and adjoint variable must be stored at every time step to ensure accurate results. This may limit application of the method to a large-scale system over a long simulation period if computer storage is a concern. (See also W90-03036) (Rochester-PTT)
W90-03091

COUPLING OF UNSTEADY AND NONLINEAR GROUNDWATER FLOW COMPUTATIONS AND OPTIMIZATION METHODS.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
A. Heckele, and B. Herrling.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 411-416, 1 fig, 13 ref.

Descriptors: *Model studies, *Groundwater movement, *Hydraulic models, *Optimization, *Algorithms, Influence functions, Unsteady flow, Nonlinear processes, Performance evaluation, Mathematical models, Mathematical equations, Numerical analysis.

Optimization procedures that couple the numerical calculation of groundwater flow and optimization have been known for some time. Willis and Finney developed a method for quasilinearly calculating influence functions. These functions describe the groundwater levels at the end of an optimization interval as a function of the decision variables active during the time interval and of the groundwater levels at the beginning of the interval. The nonlinearity is handled by iterative correction of the influence functions after each optimization. An optimization algorithm is described here that is based on the Willis and Finney method. However, in the present approach, for the influence functions the groundwater levels are exclusively functions of the decision variables and the optimization problem can be reduced simply to an equation system containing only decision variables. The calculation of the influence functions is accomplished almost completely with algorithms known from the numerical calculation of groundwater levels. The basic equations, principles of the numerical solution, calculation of the influence functions, and handling of nonlinear groundwater systems are discussed. Numerical results were presented elsewhere. (See also W90-03036) (Rochester-PTT)
W90-03096

FLOSA - 3FE: VELOCITY ORIENTED THREE-DIMENSIONAL FINITE ELEMENT SIMULATOR OF GROUNDWATER FLOW.
Politechnika Warszawska (Poland).
M. Nawalany.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 451-458, 7 fig, 4 ref.

Descriptors: *Model studies, *Groundwater movement, *Velocity, *Simulation, *Computer programs, *Finite element method, Graphics, Transport velocity representation, Mathematical equations, Grids, FLOSA-3FE model.

Transport Velocity Representation (TVR) of groundwater flow works on the velocity components as a primary variable. The representation, when supplied with additional boundary conditions, is equivalent to the mass balance equation and Darcy's Law. FLOSA-3FE is the first three-dimensional finite element simulation that approximates the solutions of the TVR equations for groundwater problems defined on a regional scale. The simulator supports arbitrary boundary conditions and arbitrary spatial distribution of pumping wells. The simulator features an automatic translation of the user-specified boundary conditions (pie-

zometric heads and/or normal fluxes) into the additional ones necessary to make the TVR and the classical theories equivalent. The resulting large and sparse algebraic equations, with the velocity components as the unknowns, are solved by outer iterations and the ICCG solver. The special searching scheme makes the ICCG solver very fast, even for the PC version of the simulator. FLOSA-3FE consists of three distinct parts: a finite element grid generator, a finite element simulation model, and a program to produce a graphical image of the groundwater pathlines. The program runs in the VAX environment under the control of a command file, but on the PC the three modules must be run separately under the user's control. Output from some simple examples is described. (See also W90-03036) (Rochester-PTT)
W90-03102

KARST HYDROGEOLOGY AND KARST ENVIRONMENT PROTECTION. VOLUME 2.
Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). 1261 p. Edited by Daoxian Yuan.

Descriptors: *Water pollution control, *Environmental protection, *Karst hydrology, *Groundwater movement, *Karst, *Geohydrology, China, Conferences, Mathematical models, Geologic fractures.

This is a collection of papers presented to the International Association of Hydrogeologists 21st Congress--Karst Hydrogeology and Karst Environment Protection held in October 1988. The volume contains 263 contributions (including abstracts) covering very broad karst areas of Asia, Europe, America, Africa and Latin America, divided into two parts--the first several papers are invited keynotes and the others are grouped into themes under the headings of: strategy of comprehensive planning and development of karst areas; regional karstology; regional distribution patterns and systematic analysis of karst groundwater; parametric study of karst groundwater; assessment of water resources; investigation techniques and the application of mathematical models; rational development, management and protection of karst and fissure groundwater; forecast and control of surface collapse; and geohydrological mapping of karst areas and geohydrological problems in nonkarst areas. (See W90-03105 thru W90-03193) (Lantz-PTT)
W90-03104

MEDIA AND MOVEMENT OF KARST WATER.
Comprehensive Inst. of Geotechnical Investigation and Surveying, Beijing (China).
Y. Chen, and J. Bian.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 555-564, 9 fig, 3 tab, 2 ref.

Descriptors: *Geohydrology, *Karst hydrology, *Groundwater movement, Carbonate rocks, Cavern flow, Karst, Geologic fractures.

The characteristics of karst water movement depend both on the pattern and the dimensions of void media of carbonate rocks. The void of carbonate rocks can be divided into two types: matrix void, and fractures with caverns. From mine and tunnel exposures, and from borehole rock samples, carbonate rocks are rarely massive and usually cut by fault, joint or foliation, into various shapes (such as triangular, trapezoid, rhombic or prisms) of various dimensions. When lying beneath the regional base level of drainage, fractures in these rocks are subject to enlargement by dissolution under the influence of the active and continuous movement of fracture water, resulting in the formation of caverns which can control the movement of the karst water and enable the formation of a unified water table. With respect to hydraulic function, karst media may be divided into three

types: storage media composing a matrix void, operating as a function for water storage; transport media which are cracks and fractures functioning as a passage for circulating water; and control media which connect caverns developed partially or entirely throughout the karst rock layer forming a unified water table. (See also W90-03104) (Lantz-PTT)
W90-03105

EXPERIMENTAL TESTS TO STUDY THE HYDRODYNAMICS ANALOGIES BETWEEN FISSURED AND POROUS MEDIA.
Universita di Reggio Calabria, Cosenza (Italy). Dept. of Soil Conservation.
S. Troisi, and M. Vurro.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 565-571, 2 fig, 10 ref.

Descriptors: *Karst hydrology, *Aquifer testing, *Groundwater movement, *Geohydrology, *Porous media, Fissure water, Geologic fractures, Flow pattern, Flow profiles, Mathematical studies.

Several tests were carried out on a one-dimensional horizontal permeometer, in which the filtering system is made up of 15 rows of suitably arranged, practically impermeable, bricks. Two series of tests were run. The test results were plotted as Reynolds' numbers versus friction factor, using Arbhabhirama's formulas. From this graph it can be seen tha the flow is laminar and, within the range of validity of Darcy's law, there are no large hydrodynamic differences between the porous media and a fissured system. In situ tests in a fissured aquifer were carried out using the same two-wells pulse method; data were plotted in the same way. These findings are in accordance with laboratory results. These experimental tests confirm that the dynamic flow behavior of such a fissured system and of porous media is comparable. (See also W90-03104) (Lantz-PTT)
W90-03106

GEOMECHANICAL AND MATHEMATICAL ANALYSIS OF KARST-FISSURE MEDIA IN KARST RESEARCH.
Changchun Coll. of Geology (China).
Y. Cao, H. Chen, and Z. Shao.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 572-582, 6 fig, 2 tab, 2 ref.

Descriptors: *China, *Karst hydrology, *Groundwater movement, *Geohydrology, Mathematical studies, Geologic fractures, China, Fissure water, Permeability, Springs, Seepage.

The Jinan spring region (in northern China) is used as an example of geomechanical and mathematic analyses to study the controlling and responsive relations of structural and karst fields. The karst water system was simulated to reveal the law of storage and migration of karst water in karst areas of northern China. The study shows that the control and response of structural and karst fields, to the karst water system, can be objectively reflected by using these methods. Quantitative or semi-quantitative analysis can be done on the inhomgeneity and anisotropy of the karst fissure media in the karst areas of northern China, although there are still some problems to be solved. These include: seepage characteristics in the fault zones, crossflow in fissures and its effect on the permeability coefficient; and an accurate evaluation of the importance of karst water. (See also W90-03104) (Lantz-PTT)
W90-03107

SOME CONSIDERATIONS ABOUT THE SIMULATION OF KARSTIC AQUIFERS.
Granada Univ. (Spain). Dept. of Geodynamic.
A. Pulido-Bosch, and A. Padilla.

IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 583-588, 5 fig, 10 ref.

Descriptors: *Aquifers, *Karst hydrology, *Simulation analysis, *Rainfall-runoff relationships, Discharge capacity, Correlation analysis, Spectral analysis, Karst, Groundwater movement.

A methodology is described which simulates a karstic aquifer in relation to the Fuente Mayor of Simat de Valldigna (Valencia province, Eastern Spain). The application of correlation and spectral analysis to time series of the daily rainfall and discharge sequences, gave an approximation of the functioning of this aquifer system. By employing deconvolution methods, the impulse response could be estimated. Results from both types of analysis--correlation and spectral, and deconvolution showed that the system can be simulated employing the classic karstic aquifer conceptual model. After several tests with different values for transmissivity (T) and storage (S), the discharge of the main spring was satisfactorily reproduced. The average value of S was 1.13% and of T 800 sq m/day. (See also W90-03104) (Lantz-PTT)
W90-03108

CONJUNCT FINITE ELEMENT-BOUNDARY ELEMENT METHOD APPLIED TO THE INVERSION OF HYDROGEOLOGICAL PARAMETERS.
Academia Sinica, Beijing (China). Inst. of Geology.
Y. Zhao.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 589-596, 8 fig, 5 ref.

Descriptors: *Geohydrology, *Finite element method, *Groundwater movement, *Karst hydrology, *Mathematical analysis, Least squares method, Statistical analysis, Flow profiles, Taiyuan, China, Hydraulic gradient.

A new numerical method is proposed, for inverting the distribution of the geohydrological parameters from observed data. This method is based on the Conjunct Finite Element-Boundary Element Method (CFEBEM) and Least Square Method (LSM). The CFEBEM shows the flexibility of the FEM and the accuracy of the BEM. The inverting method is applicable not only to determining the parameters, but also to calculating the flow field in the same run. Three inverting techniques were tested by utilizing observed water head and hydraulic gradient data. An application to the study of the groundwater system of the Taiyuan area in China demonstrated the efficiency of this technique. (See also W90-03104) (Lantz-PTT)
W90-03109

AGE DATING OF THE GROUNDWATER IN THE SPRING AREA OF JINAN CITY.
Changchun Coll. of Geology (China).
P. Fang, Y. Cao, K. Tang, X. Li, and S. Wang.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 597-605, 4 fig, 4 ref.

Descriptors: *Karst hydrology, *Isotope studies, *Isotopic tracers, *Environmental tracers, *Springs, *Groundwater dating, *China, Jinan City, Spring water, Chemical analysis.

Environmental isotopes were used to estimate the age of groundwater in the spring water of Jinan City, China. The chemical age was estimated by using the theory of dissolution dynamics on carbonate minerals. The result of the stable isotope analysis shows that groundwater in the Jinan spring water system comes from an infiltration of

precipitation water. Different exposure conditions, stable isotope analysis, and isotope age calculations for every spring group, show that the Bhoatu Spring water is of shallow circulation, while Heihu Spring comes from water of moderately-deep circulation with a longer migration time for the groundwater. The Wulong Spring comes from the deepest circulated water; since its recharge source is the farthest away, it is considered to be the oldest. The calculated chemical age is close to the isotopic age. Therefore, it is an effective method for determining the age of groundwater in karst aquifers with conventional analysis of information. (See also W90-03104) (Lantz-PTT)
W90-03110

HYDROLOGICAL DEFINITION OF KARST AREAS.
Sarajevo Univ. (Yugoslavia). Inst. of Water Resources Engineering.
I. Avdagic.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 621-618, 6 fig, 10 ref.

Descriptors: *Catchment areas, *Rainfall-runoff relationships, *Runoff, *Karst hydrology, *Surface-groundwater relations, Reservoirs, Water level, Groundwater budget, Groundwater movement, Mathematical models, Hydrologic models.

In the procedure of runoff calculation, catchment areas or reservoirs are classified into subsystems with constant characteristics. Basic measuring values are water levels, flows, precipitations and catchment areas. Measurements of underground water levels are made in reservoirs and conducting strata; flows are measured on the outcrops and precipitation in representative locations of the catchment area. Measured data are used for the determination of conducting stratum and reservoir characteristics. Variation of characteristics at the reservoir depth is step-wise; these characteristics for each segment between two steps are approximately constant. Systematic measurements on calibrated sections, per segment with constant characteristics, enable the determination of both runoff and water regime. (See also W90-03104) (Lantz-PTT)
W90-03112

STOCHASTIC MODELLING OF THE KARST SPRING OF XIN'AN, SHANXI PROVINCE.
China Univ. of Geosciences, Beijing, China.
A. Chen, H. Liu, J. Xu, and J. Shao.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 621-628, 5 fig, 2 ref.

Descriptors: *Stochastic models, *Karst hydrology, *Springs, Groundwater movement, Xinan, China, Geohydrology, Flow discharge, Hydrologic models, Model studies, Karst.

A complete karst spring system was simulated by using three stochastic models: (1) the sliding average model (SA); (2) the autoregressive-sling average model (ARSA); and (3) frequency spectrum analysis and residual-variance autoregression of average monthly spring discharge (F-AR). A case study shows that the results of modeling in good agreement with measured data. The Xin'an Spring is the largest karst spring in southeastern Shanxi, China. Its average annual discharge amounts to 11.9 cu m/sec, and the water quality is excellent. Since Shanxi, an important energy base in China, is deficient in water resources, investigation of this spring is of great significance. By using the principles of systematic theory and stochastic hydrology, the spring discharge was forecasted and the recharge of groundwater was calculated. The study demonstrated that the ARSA and F-AR models are more effective. T fitting results were in agree-

ment with the observed data. (See also W90-03104) (Lantz-PTT)
W90-03113

REGULARITY OF FORMATION OF THE GUOZHUANG KARST SPRING AND THE STOCHASTIC SIMULATION OF ITS DISCHARGE.
Tongji Univ., Shanghai (China).
B. Zhan, N. Wang, and F. Guo.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 629-636, 5 fig, 3 ref.

Descriptors: *Hydrologic models, *Karst hydrology, *Stochastic hydrology, *Simulation analysis, Flow discharge, Springs, Geohydrology, Precipitation, China, Mathematical models.

The Guozhuang Spring in Shanxi Province, China, exposed in the Middle Ordovician limestone, is one of complete-drainage, and erosional structural ascending type. Spectral analysis of the spring discharge and precipitation, showed that the cycles of the spring discharge are 8.5 years, 25 months and 12 months, with a lag time of 6-7 months. The spring discharge is closely correlated with the precipitation within a period of 11 years from the previous year. Two stochastic mathematical models, the multiple regression model and the moving average model, were successfully established to forecast the spring's discharge. (See also W90-03104) (Lantz-PTT)
W90-03114

MATHEMATICAL SIMULATION OF HYDRO-LOGIC REGIME OF CHAOHUA SPRING IN MIXIAN COUNTY.
Nanjing Univ. (China).
B. Chen, and X. Zhou.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 637-645, 5 fig, 3 ref.

Descriptors: *Groundwater mining, *Springs, *Hydrologic budget, *Mathematical models, *Chaohua Spring, *China, *Karst hydrology, Geohydrology, Karst, Hydrologic models, Precipitation, Catchment areas, Finite element method.

Chaohua Spring is a typical karst spring located in northern China. The hydrological regime of the spring is influenced by several factors, including: precipitation, topography, and geologic structure. Based on an investigation and analysis of the precipitation series of Mixian County, different methods have been adopted to simulate hydrologic curves that represent two different catchment areas of the spring. The Suishui River Basin is a natural catchment area of the spring which is simulated by a finite element numerical method. The Youshui River basin is a newly expanded catchment area following the exploitation of spring water, which is simulated by an integrated model of multi-element regression and autoregression. An effective prediction carried out for the hydrologic regime of Chaohua Spring, caused by exploitation before the year 2000, under the condition of confluence from two different catchments. (See also W90-03104) (Author's abstract)
W90-03115

ANALYTIC MODELS OF GROUNDWATER FLOWS TO KARST SPRINGS.
China Univ. of Geosciences, Wuhan, China.
M. Lin, and C. Chen.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 646-654, 2 fig, 5 ref.

Descriptors: *Model studies, *Groundwater movement, *Karst hydrology, *Springs, *Hydrologic

models, Karst, Mathematical studies, Laminar flow, Flow profiles.

Four conceptual analytical models which describe the laminar or turbulent groundwater flow to karst springs have been established. The first two models show one-dimensional flow and radial flow, in accordance with the Darcy (linear) law. The other two give the expression individually of one-dimensional flow and radial flow, following nonlinear law. The solution of the models is the same as the traditional spring recession equations for the laminar flow and turbulent flow. They interpret the character of spring recession in theory. The mean hydraulic conductivity of the spring area is estimated according to the expression of the recession coefficient. Other expressions are also given which indicate the proportionality of the square root of the attenuation coefficient to the karst channel diameter and the fracture width. (See also W90-03104) (Lantz-PTT)
W90-03116

HYBRID SIMULATION FOR KARST WATER SYSTEMS--EXEMPLIFIED BY BEISHAN KARST WATER SYSTEMS.
Institute of Karst Geology, Guilin (China).
G. Cui, Y. Zhu, and X. Qin.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 655-662, 5 fig, 1 ref.

Descriptors: *Simulation analysis, *Karst hydrology, *Groundwater movement, *Model studies, *China, *Hydrologic models, Mine dewatering, Groundwater recharge, Flow discharge, Hydraulic profiles, Flood discharge.

The karst water system of the Beishan mining district consists of two subsystems: a recharge area and a runoff-discharge area. Equivalent tank models in association with a cluster of tubes of various diameters were used to simulate the location of five hydraulic channels and the parameters of the flow capacity, to predict the flood discharge in dewatering of mines during the maximum rainfall (probability is 2% and 0.6%). With the boundary conditions of inflow, a quasi-tridimensional, laminar-conduit coupling linear model was adopted for predicting the maximum yields of pits in the subsystem of the runoff-discharge area. (See also W90-03104) (Author's abstract)
W90-03117

THRESHOLD AUTOREGRESSIVE MODEL APPLIED TO PREDICTION OF KARST SPRING FLOW.
Institute of Karst Geology, Guilin (China).
A. Dai, D. Yuan, W. Cai, and P. Bidaux.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 663-670, 1 fig, 3 ref.

Descriptors: *Karst hydrology, *Springs, *Groundwater movement, *Regression analysis, *Model studies, Hydrologic models, Mathematical models, Mathematical analysis.

The threshold autoregressive model (TAR) is a nonlinear sequential model which is segmentedly linear. Therefore, the fixed steps, parameter estimation and diagnostic checking of the Box-Jenkins method used for linear models may also be applied to the TAR model. The advantage of the model is that segment linearization processing can be used, so that the non-linear model may adopt the fixed steps, parameter estimation and diagnostic checking of a linear model in the establishment of a nonlinear model. This simplifies calculation procedure and the model can be established automatically on the computer. The Akaike Information Criterion (AIC) used for model discrimination makes it more convenient for establishing the model and carrying out the prediction under the condition of small sample capacity. It is of significance in karst

spring flow prediction with short series of observation. When this threshold autoregressive model is used in the prediction of future time intervals, the extrapolation should be controlled within a certain limit as in other statistical models. The time interval of extrapolated prediction should not be greater than the delay parameter. Otherwise, estimated values can only be used in some of the items in the equation, and error will increase. (See also W90-03104) (Lantz-PTT)
W90-03118

DISCRETE STATE COMPARTMENT MODEL AND ITS APPLICATION TO FLOW THROUGH KARSTIC AQUIFERS.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
E. S. Simpson.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 671-676, 2 fig, 11 ref.

Descriptors: *Groundwater movement, *Karst hydrology, *Aquifers, *Model studies, *Hydrologic models, Flow profiles, Mathematical models, Flow velocity, Darcys Law, Discrete State Component model, Mathematical equations, Hydrodynamics, Heat, Tracers.

Flow through openings in karstic aquifers can be, and often is, non-Darcian. Depending on the size and shape of the openings, and on the flow velocity, flow can be Darcian, non-Darcian laminar, or turbulent. Where the flow is non-Darcian, numerical models that assume the validity of Darcian flow everywhere in the flow system should not be used. The Discrete State Compartment (DSC) model obtains solutions by iterating a recursive equation, derived from the equation of continuity, over a network of cells that represents the flow system. No assumption is made on the flow regime other than to assume complete mixing of fluids in each cell at each interaction. The design of the network and the initial guess of flow circulation requires some a priori knowledge of geologic and hydrologic conditions. The model simulates fluid, heat, and tracer transport, and calculates residence times. (See also W90-03104) (Author's abstract)
W90-03119

METHODS FOR STUDYING SUBMARINE DISCHARGE OF KARST WATER.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
I. S. Zektser, and A. V. Meskheteli.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 677-681, 4 ref.

Descriptors: *Data acquisition, *Sampling, *Flow discharge, *Karst hydrology, *Submarine springs, *Groundwater movement, Geohydrology, Remote sensing, Temperature, Conductivity, Marine environment, Bottom sediments, Mathematical studies.

Methods for the detection and mapping of submarine karst springs are discussed, including: (1) remote sensing techniques; (2) combined profiling, comprising seismic sounding and temperature and electric conductivity measurements at the bottom-water interface; (3) vertical measurements and sampling of sea water and bottom sediments; and (4) the use of diving equipment. Techniques are presented for estimating the rates of submarine discharge of groundwater, based on the consideration of the salt balance of a sea bottom area where ground and sea waters mix and where the submarine spring outlet is covered with loose sediments. Data of combined profiling or results of hydrochemical examination of pore solutions are used in these computations. The same principle may be applied to computations of submarine discharge of groundwater using temperature data. However, the salinity of the near-bottom water layer is subjected to much smaller variations in time, which

makes it possible to consider with more confidence the salt-mass transfer in the bottom sediments--near-bottom water system to be steady. (See also W90-03104) (Lantz-PTT)
W90-03120

FISSURE-KARST WATER RESOURCE EVALUATION IN A WELL FIELD NEAR XUZHOU.
Nanjing Univ. (China).
C. Xie, X. Zhu, W. Huang, and G. Chen.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 682-690, 6 fig, 2 tab.

Descriptors: *China, *Data acquisition, *Water resources data, *Wells, *Model studies, *Karst hydrology, *Geologic fractures, *Groundwater movement, Fissure water, Finite element method, Mathematical equations, Geohydrology, Hydraulic head, Mathematical analysis, Karst.

An evaluation of fissure-karst groundwater resources has been conducted in a well field located in the western suburbs of Xuzhou, China. An approximate analytical solution has been derived to estimate the future groundwater head on the boundaries. A finite element method has been used to solve the inverse problem of determining the parameters and predicting the groundwater head. Satisfactory results were achieved. (See also W90-03104) (Author's abstract)
W90-03121

SOME NEW IDEAS ON THE PREDICTION OF TUNNEL INFLOW IN KARST AREA BY WATER BALANCE METHOD.
Second Inst. of Railway Survey and Design, Chengdu (China).
For primary bibliographic entry see Field 2A.
W90-03122

ANALYSIS AND COMPARISON OF SOME VALUES OF TRANSMISSIVITY, PERMEABILITY AND STORAGE FROM THE EUGANEAN THERMAL BASIN.
Padua Univ. (Italy). Inst. of Geology.
R. Antonelli, and P. Fabbri.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 707-718, 2 tab, 7 ref.

Descriptors: *Groundwater budget, *Transmissivity, *Permeability, *Geohydrology, *Italy, *Hydraulic properties, *Thermal water, Aquifers, Wells, Pumping tests, Euganean Thermal Basin, Karst hydrology, Hydraulic conductivity, Fissure water, Geologic fractures.

Twenty-eight pumping tests were carried out in the Euganean Thermal Basin in Italy, using active wells belonging to the various drilling concessions in Abano Terme and Montegrotto Terme. In the seven tests examined, use was always made of at least one pumping well or a piezometer. The thermal aquifer in question is pressurized and consists of fractured, mainly carbonate, rocks of unknown depth. The type of analysis used in these tests to determine transmissivity, hydraulic conductivity and storage coefficient, were those relating to aquifers in porous media, and include the Kanvar, Hantush, and Zangar methods applicable to partially penetrating wells. The Saad method, specifically for aquifers in fissured rocks, provided a horizontal transmissivity value as well as values relating to horizontal and vertical hydraulic conductivity, meaning that the vertical hydraulic conductivity could be verified as being macroscopically greater. (See also W90-03104) (Lantz-PTT)
W90-03123

KARST WATER RESOURCES, THEIR ALLOCATION, AND THE DETERMINATION OF ECOLOGICALLY ACCEPTABLE MINIMUM

FLOWS: THE CASE OF THE WAIKOROPUPU SPRINGS, NEW ZEALAND.
Auckland Univ. (New Zealand). Dept. of Geography.
P. W. Williams.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 719-723, 1 tab, 8 ref.

Descriptors: *Water resources development, *Karst hydrology, *Waikoropupu Springs, *Springs, *New Zealand, Hydraulic models, Groundwater depletion, Aquifers.

Karst water resources are often exploited before their potential has been fully assessed. At karst springs, resource determination is often by base-flow recession analysis. This yields the volume of the dynamic reserves. An alternative approach is to estimate the total volume in storage from the product of the average discharge and average residence time. This yields a much large volume. Figures calculated vary according to modeling assumptions. The allocation of the resources among competing uses raises another set of problems, particularly if demand outstrips renewable supply. A key problem is how to establish a scientifically sound rationale for determining the minimum residual flow that will be sufficient for ecosystem maintenance. These points are discussed in relation to the Waikoropupu Springs with an average annual discharge of 15 cu cm/sec, mean residence time of 8 years, and aquifer volume of 3.8 cu km. (See also W90-03104) (Author's abstract)
W90-03124

HETEROGENEITY IN CARBONATE AQUIFERS--A CASE STUDY FROM THE MENDIP HILLS, ENGLAND.
Bristol Univ. (England). Dept. of Geography.
S. L. Hobbs, and P. L. Smart.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 724-730, 3 fig, 14 ref.

Descriptors: *Karst hydrology, *Water resources development, *Groundwater movement, *Aquifers, *Carbonate rocks, *Mendip Hills, *England, Case studies, Hydraulic conductivity, Pumping tests, England, Permeability, Boreholes, Geohydrology, Karst hydrology.

Single borehole bailer tests show a 6 order of magnitude variation in hydraulic conductivity, indicating a very high heterogeneity for the Carboniferous Limestone aquifer, in the Mendips Hills, Somerset, England. Comparison of these values with those from long-term pump tests demonstrate that the pump tests give less variable results due to integration over a larger aquifer test volume. Packer tests demonstrate large differences between the hydraulic conductivity of openings and inter-opening blocks, demonstrating the vertical inhomogeneity of the aquifer. A plot of specific yield, which varies by only a small amount between boreholes, against permeability, shows the greater importance of void integration in controlling hydraulic conductivity than width of opening. (See also W90-03104) (Author's abstract)
W90-03125

ESTABLISHING THE RESIDENCE TIME OF GROUND WATER IN KARST.
Karlova Univ., Prague (Czechoslovakia). Dept. of Hydrogeology and Engineering Geology.
J. Silar.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 731-734, 14 ref.

Descriptors: *Radioactive dating, *Dating, *Groundwater dating, *Aquifers, *Karst hydrolo-

gy, *Groundwater budget, Radioisotopes, Geohydrology, Carbon radioisotopes, Tritium, Confined aquifers, Hydrologic models, Geohydrology, Groundwater movement, Czechoslovakia, Carbonate rocks, Isotope studies, Aquicludes, Limestone.

Methods using environmental radionuclides contained in groundwater have been introduced to geological investigations and brought to a routine level to determine the radiometric groundwater age, which can then be related to its residence time. Radiocarbon and tritium are the most frequently used radionuclides. When dating groundwater in karst environment by radiocarbon, its input and output values, when entering and leaving the geohydrological system, have to be considered. The piston-flow model seems to be most appropriate in confined aquifers in carbonate rocks overlain by aquicludes, the completely mixed reservoir model in unconfined geohydrological structures with a concentrated outflow, and the injection model in confined aquifers with intrusion of modern water, mainly due to interferences in the piezometric level by pumping or other human activities. The base-flow model fits in shallow karstified aquifers with inflow of groundwater of deeper origin from confined aquifers. Old groundwater of deep origin occurs in the karstified environment more often than anticipated. In karstified geohydrological structures in Czechoslovakia, all types of groundwater flow systems represented by the mentioned models were encountered when dating groundwater in Paleozoic limestone structures in the Bohemian Massif and in the Carpathian System, with 3-H and 14-C groundwater ages ranging from modern to more than 4000 years before present. (See also W90-03104) (Lantz-PTT)
W90-03126

STRUCTURE OF KARSTIC RESERVOIRS ACCORDING TO MICROTECTONIC AND FISSURAL ANALYSIS, AREA OF THE EXPERIMENTAL SITE OF YAJI, GUILIN, CHINA.
Montpellier-2 Univ. (France).
C. Drogue, M. Razack, and D. Yuan.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 735-740, 4 fig, 9 ref.

Descriptors: *Karst hydrology, *Geologic fractures, *Fissure water, *China, *Groundwater reservoirs, Guilin, Groundwater movement, Aquifers, Karst, Tectonics, Geohydrology.

The Devono-Carbonifer limestones and dolomites of the Guangxi area of China are karstic aquifers whose fissural structure originates from three tectonic episodes of Mesozoic and Cenozoic age. One is a distension phase which proved important with respect to groundwater flow. The fractures surveyed in the field which play a geohydrological role are identical to those mapped on ERTS satellite images. They consist of fissures nearly oriented North-South and Northeast-Southwest. (See also W90-03104) (Author's abstract)
W90-03127

STUDY OF SHALLOW SEISMICS FOR PREDICTING COLLAPSE AND CAVE IN SOIL LAYERS.
Institute of Karst Geology, Guilin (China).
For primary bibliographic entry see Field 7B.
W90-03128

APPLICATION AND DEVELOPMENT OF ELECTROMAGNETIC WAVE TOMOGRAPHY IN KARST EXPLORATION.
Beijing Computer Center (China).
For primary bibliographic entry see Field 7B.
W90-03129

AUTOMATIC TREATMENT OF PHOTO-LINES.
Universidad del Pais Vasco, Bilbao (Spain). Dept. of Geodynamic.

For primary bibliographic entry see Field 7C.
W90-03130

USE OF REMOTE SENSING METHODS IN GROUNDWATER PROTECTION.
J. Svoma.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 762-765, 3 ref.

Descriptors: *Groundwater budget, *Remote sensing, Photography, Groundwater quality, Water quality control, Natural gas, Oil pollution.

Photographic methods have proved their worth in rock and groundwater protection from contamination. Changes in vegetation can be used for increasing the vertical reach by pollutant detection devices into the underground. Natural gas leakages and rock contamination by oil products, nitrates and other compounds can be determined with the help of this methodology, which is applicable in temperate zones. The easiest interpretation of contamination is by photography with color and color infrared film simultaneously. The widespread application of remote photographic imaging is limited by several factors: seasonal and local absence of vegetation; depth of the rhizosphere; and detectable reaction of plants up to the critical concentration of pollutant. (See also W90-03104) (Lantz-PTT)
W90-03131

PROSPECTING FOR KARST FRACTURE GROUNDWATER IN THE WANMAN FAULT-BLOCK MOUNTAINOUS AREA OF TAIHANG MT. USING PHOTO-LINEAMENTS.
Ministry of Metallurgical Industry, Beijing (China). Inst. of Geotechnics, Hydrogeology and Photogrammetry.
For primary bibliographic entry see Field 7B.
W90-03132

LOCATION OF CONCEALED AREAS WITH INTENSIFIED KARST-SUFFOSION PROCESSES USING HELIUM-SURVEY AND HYDRO-BIOLOGICAL DATA.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 7B.
W90-03133

ISOTOPIC STUDY OF THE GROUNDWATER AGES IN REGION OF CARBONATE ROCKS.
Academia Sinica, Beijing (China). Inst. of Geology.
H. Shi, Z. Cai, and Z. Xu.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 785-792, 2 fig, 4 tab.

Descriptors: *Groundwater dating, *Isotope studies, *Carbonate rocks, *Radioactive dating, *Dating, *Karst, *Groundwater movement, *China, *Karst hydrology, Tritium, Carbon radioisotopes, Taiyuan, Flow profiles, Hydrologic models, Model studies.

Two hundred forty values of tritium, carbon-14 and carbon-13 of groundwater, surface water and precipitation have been measured for the Taiyuan region of China. The results show that there is a 3-dimensional groundwater flow system in the studied region. Different mixed groundwater models should be selected for the areas of recharge runoff and discharge of karst groundwater. Groundwater ages at 13 sites in the studied region were obtained after making corrections for mixing of young water, dilution by dead carbon, and the variation in initial carbon-14 concentration. The velocity of groundwater flow and the runoff were determined on the basis of the obtained groundwater ages. (See also W90-03104) (Author's abstract)
W90-03134

APPLICATION OF STABLE ISOTOPE TO THE RESEARCH ON KARST WATER IN TAIYUAN AREA.
Academia Sinica, Beijing (China). Inst. of Geology.
S. Pan.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 793-799, 4 fig, 3 tab, 3 ref.

Descriptors: *Karst hydrology, *Isotope studies, *Taiyuan, *Groundwater recharge, *China, *Groundwater movement, Mixing, Radioisotopes, Springs.

The influence of exploiting karst water by the Gujiao Coal Mine on the discharge rate of major springs--Languan, Jinci in Taiyuan area, Shanxi Province was studied. Surface water and karst water in this area have been studied in detail. A mixing line for the West Hills karst water system and shallow water was determined. Recharge by shallow water to the Jinci Spring is about 36%. Two karst water systems were distinguished--the West Hills system and the East and North Hills system (part of which is the Languan Springs). S-isotope data indicate that there is less supply to The Languan Spring from the West Hills karst water system, then to the Jinci Spring. (See also W90-03104) (Lantz-PTT)
W90-03135

EXPERIENCES OF PROSPECTIONS OF RADON-222 IN WATERS.
Institut Jozef Stefan, Ljubljana (Yugoslavia).
I. Kobal, D. Novak, and U. Premru.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 800-808, 3 fig, 12 ref.

Descriptors: *Earthquakes, *Yugoslavia, *Karst hydrology, *Isotope studies, *Radon radioisotopes, *Hot springs, *Seismic properties, Tectonics, Geohydrology.

Radon-222 concentrations and concentration climaxes have recently been correlated with the appearance of earthquakes in seismicly active areas, i.e. around Ljubljana, Yugoslavia. Agreement has been noted mainly in hot springs with deep circulation, although these correlation methods alone did not give data about the time and magnitude of an earthquake, nor the place of an earthquake. However, the method makes it possible to confirm the already established seismo-tectonic model of Slovenia, and has become very important in studying tectonic mechanisms with respect to the time migration of earthquakes. (See also W90-03104) (Lantz-PTT)
W90-03136

ISOTOPIC COMPOSITION OF HYDROGEN AND OXYGEN OF KARST WATER AND HYDRODYNAMIC CONDITION IN CENTRAL HEBEI DEPRESSION.
Institute of Geology, Beijing (China).
G. Li, P. Zhang, J. Wang, and F. Jiang.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 809-815, 5 fig, 1 tab, 2 ref.

Descriptors: *Data acquisition, *Hydrologic data, *Isotope studies, *Karst hydrology, *Geohydrology, *Hydrogen, *Oxygen isotopes, *China, Groundwater recharge, Karst, Confined groundwater.

Three aquifer systems of different ages have been measured for delta-D and delta-18-O values. The karst water occurring in the Middle-Late Proterozoic (Pt) and Early Paleozoic (Pz) limestones has a delta-D value ranging from -80 parts per thousand

(ppt) to -65 ppt and delta-18-O from -11 ppt to -5 ppt. The delta-18-O shift may indicate the isotopic exchange between water and rocks and the relict of co-diagenetic formation water. From Taihang Mountain in the west towards the center of the depression, four hydrodynamic zones have been recognized, on the basis of delta-D values: (1) a recharge zone, (2) a water exchange zone, (3) an artesian zone, and (4) a discharge zone. The delta-D values increase progressively from the recharge zone to the center of the depression. The delta-D value of recharge water is about -80 ppt and that for the exchange zone ranges from -75 ppt to -70 ppt. The delta-D value of water in the discharge zone is identical to that of the water from the oil-generating sandstone of the Lower Tertiary (usually higher than -65 ppt). It is suggested that the most developed karst system is found in the exchange zone, and should be taken into account in oil and gas exploration and exploitation. (See also W90-03104) (Author's abstract)
W90-03137

ENVIRONMENTAL ISOTOPIC STUDIES OF KARST WATER SYSTEM OF THE GUOZHUANG SPRINGS, SHANXI, CHINA.
China Univ. of Geosciences, Wuhan, Hubei, China.
H. Wang, H. Zhou, and Y. Lian.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 816-822, 4 tab.

Descriptors: *Karst hydrology, *Infiltration, *Rainfall infiltration, *Isotope studies, *Tritium, *Guozhuang Springs, *Karst hydrology, *Groundwater budget, *China, Karst, Model studies, Rain, Groundwater recharge, Aquifers, Groundwater recharge, Fente River, Mathematical models.

The environmental isotope 3-H in rain is used as data for model for the calculation of karst water resources. The data from rain, groundwater of Carboniferous-Permian (C-P) aquifer and Fenhe River were studied. The average retention time and reserves was calculated using a multi-input, mono-output model. The mean retention time of groundwater in Guozhuang Springs is 122-125 years, with a water reserve of 32.9-33.8 billion cu m. It is reasonable to use a multi-input, mono-output mixture-piston model. It is concluded that is would be of practical value to restore the 3-H spectrum of rain by linear multivariate regression analysis with respect to rainfall, altitude, and continent effects, in cases which lack systematic observation data for 3-H. (See also W90-03104) (Lantz-PTT)
W90-03138

APPLICATION OF NUCLEAR TECHNIQUES TO EXPLOIT VUGULAR PORE WATER IN RED BEDS, SICHUAN BASIN.
Institute of Applied Nuclear Technology of Sichuan, China.
Z. Wu.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 823-831, 5 fig, 2 tab, 3 ref.

Descriptors: *Groundwater mining, *Interstitial water, *Sichuan, *Isotope studies, *Groundwater budget, Radioactivity techniques, Gamma radiation.

The vugular pore water distributed over Mesozoic 'Red Beds' in Sichuan Basin, China, is of significance in determining water supply, although its water capacity varies greatly. This water supply is controlled by the unevenly distributed vugular solution porosity. Research achievements in groundwater exploration using techniques for isotopic and radioactive measurements are presented. In Sichuan Basin, gamma radiation zones rich in vugular pore water give generally negative anomalies.

The shape of this anomaly is irregular, with a trough often showing the development spot of vugular pore. Best results are obtained when two methods, e.g., gamma radiation and PO210 measurement in topsoil are used in combination to locate the zone rich in vugular pore water in areas covered by overburden. (See also W90-03104) (Lantz-PTT)
W90-03139

CARBON ISOTOPE EXCHANGE IN KARST GROUNDWATER.
International Atomic Energy Agency, Vienna (Austria).
R. Gonfiantini.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 832-837, 3 fig, 5 ref.

Descriptors: *Isotope studies, *Carbon radioisotopes, *Karst hydrology, *Groundwater movement, Carbon, Libya, Bicarbonates, Aquifers, Limestone, Karst.

Carbon isotope data from Cyrenaica, northern Libya, were used to evaluate the exchange rate of bicarbonate dissolved in groundwater with the aquifer limestone matrix. The rate of this reaction is about half the carbon-14 decay rate; so the half reaction time is approximately 11,000 years. (See also W90-03104) (Author' abstract)
W90-03140

HYDROCHEMICAL FACIES AS HYDRAULIC BOUNDARIES IN KARSTIC AQUIFERS--THE EDWARDS AQUIFER, CENTRAL TEXAS, U.S.A.
Texas Univ. at Austin. Dept. of Geological Sciences.
J. M. Sharp, and T. J. Clement.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 841-845, 2 fig, 6 ref.

Descriptors: *Geochemistry, *Groundwater barriers, *Water chemistry, *Karst hydrology, *Edwards aquifer, *Texas, *Aquifers, Groundwater quality, Dissolved solids, Saline water intrusion, Calcium, Sulfates, Magnesium, Chlorides, Geochemistry, Oil fields, Springs, Wells, Brines.

The Edwards aquifer and the Edwards Plateau aquifer are faulted, cavernous, and highly transmissive aquifers which are the principal sources of water for 2 million people. The southern and eastern boundaries of the aquifers are demarked by the 'bad-water' zone hydrochemical facies in which the waters' total dissolved solids content abruptly increases to over 1000 mg/L. Although this boundary is relatively stable, the more saline water does flow updip towards major springs and well fields. While the freshwater zone hydrochemical facies is predominantly Ca-HCO3, four bad-water zone facies are present: Ca-SO4, Ca-Mg-SO4 with high Na and Cl, Na-Cl, and Na-Cl-SO4-HCO3 with the anions approximately coequal. These four facies result from the varying effectiveness of several processes which operate along aquifer strike. These are rock-water equilibration within the aquifer, flow of oil-field brines updip or upwards along faults, cross-formational flow from underlying aquifers, and flow system isolation. (See also W90-03104) (Author's abstract)
W90-03141

FLUORITE SATURATION AND EQUILIBRIUM TRENDS IN THE GROUNDWATER SYSTEM FROM THE KARST PLAINS OF SOUTHERN INDIANA, USA.
Ibadan Univ. (Nigeria). Hydro/Engineering Geology Unit.
U. M. P. Amadi, and N. C. Krothe.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st

Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 847-855, 5 fig, 8 ref.

Descriptors: *Groundwater quality, *Fluorite, *Water chemistry, *Karst, *Indiana, *Geochemistry, Limestone, Gypsum, Geohydrology, Fluorides, Chemical composition, Hydrogen ion concentration, Chemical properties, Alkalinity.

The Ste. Genevieve Limestone in southern Indiana is known to foster minor occurrences of fluorite. The fibrous variety is interpreted as a possible replacement of satin spar gypsum by fluorite. Hydrogeochemical evidences in support of such a replacement process are summarized. Despite such evidences, fluoride concentration in groundwater ranges from 0.1 to 5 mg/L with an average of 1 mg/L. The groundwater, however, remains essentially undersaturated with respect to fluorite in both the recharge and discharge areas. Equilibrium estimates reveal that at relatively high F(-) concentration (close to 5 mg/L) and pH nearly neutral or slightly alkaline (7.4), the groundwater approaches saturation with respect to fluorite. This condition may not always be fulfilled since ion activities of other aqueous species present, tend to vary in relation to changes in pCO2 and pH along flow. Fluorite saturation seems to be controlled by those other aqueous phases that also buffer the groundwater system. (See also W90-03104) (Author's abstract)
W90-03142

CONTRIBUTION OF AN INFORMATIZED CONCEPT TO THE CHEMICAL ANALYSIS OF GROUNDWATER SERIES.
Ecole Polytechnique Federale de Lausanne (Switzerland). Lab. de Geologie.
A. Parriaux, and T. Lutz.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 858-863, 4 fig, 1 ref.

Descriptors: *Groundwater quality, *Chemical analysis, *Automation, Computers, Data interpretation.

The study of temporal geochemical variations of groundwaters implicates a great confidence in the analysis of the compounds. Although, these variations are often small, one still must ensure that the fluctuations of results are real and not due to instrumental noise. A manual analysis does not provide verification, especially when a great number of samples are involved. The system developed by the Laboratoire de Geologie de l'Ecole Polytechnique de Lausanne, is almost entirely informatized and automated, but is still under the narrow control of the chemist. The gain is sensitive mainly for the processing of the calibration curve and the correction of drift. (See also W90-013104) (Lantz-PTT)
W90-03143

IMPORTANCE OF THE SAMPLING RHYTHM IN THE HYDROCHEMICAL STUDY AND HYDROCINEMATICAL KNOWLEDGE OF KARSTIC AQUIFERS.
Centre Univ. d'Avignon (France). Hydrogeology Lab.
B. Blavoux, and J. Mudry.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 864-869, 4 fig, 5 ref.

Descriptors: *Geochemistry, *France, *Water sampling, *Data acquisition, *Karst, *Aquifers, *Water chemistry, Mountain streams, Springs, Sampling.

The weekly rhythm study of the physical and chemical variation of several French karst springs (Alps, Jura, Provence and Pyrenees Mountains) at

the hydrological cycle scale, give the same information about the hydrocinematical behavior of the systems as a daily (or hourly) sampling at the flood scale. This observation was checked under various climates and on systems with dissimilar infiltration subsidence times (one or two days to several months). The comparisons of sampling rhythms were done on very different karst aquifers: The Verneau system with very strong and high frequency hydrodynamic and hydrochemical variations (wide karstification, impervious and little intake area); The Groseau system, with much inertia in its variations (poorly karstified), notwithstanding its small size; and the Fontaine de Vaucluse, with inertia due to the size of the system, in spite of a good karstification. High frequency sampling rhythms (daily or hourly) allows the analyst to study the lasting of high frequency chemical disturbances (as much in flood periods as in low-water). Inversely, only the weekly rhythm during cycles approaches the seasonal behavior of the system (influence of seepage and importance of chemically invariable reserves). Therefore, both studies are complementary. (See also W90-03104) (Lantz-PTT)
W90-03144

IDENTIFICATION OF GROUNDWATER FLOW IN A KARSTIC AQUIFER FROM HYDROCHEMICAL MEASURES ALONG BOREHOLES (EXPERIMENTAL SITE OF GUILIN, CHINA).
Montpellier-2 Univ. (France). Lab. d'Hydrogeologie.
P. Bidaux, D. Yuan, A. Dai, and W. Chai.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 871-876, 2 fig, 7 ref.

Descriptors: *China, *Groundwater movement, *Karst hydrology, *Aquifers, *Water chemistry, Chemical analysis, Karst, Magnesium, Manganese, Bicarbonates, Sodium.

At an experimental site in Guilin (southern China), hydrochemical logging was carried out in boreholes to identify deep groundwater circulation in an aquifer which was formed by fissured and karstic carbonate rocks. The time-and space-variations of the chemical composition of water, from one borehole to another, as well as versus depth in a given borehole, prove that intense circulation does occur as deep as was investigated (up to 90 m). The stability of the concentration of some elements (Na(+), HCO3(-)) contrasts with the variability of others, especially Mg(2+) and Mn which appear to be the best natural tracers. Focus was placed on a borehole in which magnesium and manganese concentrations varied within a very large range from top to bottom, and during and after rainfall. These variations result from a rapid inflow at the major fracture crossings in the borehole, which generates circulation up and down within the water column. (See also W90-03104) (Lantz-PTT)
W90-03145

GEOCHEMISTRY OF SOME SULPHATE GROUND WATERS IN RELATION WITH GYPSUM KARST (ALMERIA, SOUTHEASTERN SPAIN).
Granada Univ. (Spain). Dept. of Geodynamic.
J. M. Calaforra, and A. Pulido-Bosch.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 877-882, 3 fig, 1 tab, 12 ref.

Descriptors: *Geochemistry, *Sulfates, *Groundwater movement, *Gypsum, *Spain, *Karst hydrology, Karst, Aquifers, Springs.

The intermontane neogene basin of Sorbas (Betic Cordillera, Southeastern Spain) extends over an area of about 200 sq km. From a geohydrological standpoint it is composed of karstified materials,

overlain and interbedded with detrital, marly layers, that form a heterogeneous aquifer ensemble. Hydrochemical calculations were performed based on the degree of saturation of groundwater coming from a number of wells and springs in the area. As a result, main hydrochemical types present and the possible geohydrological connections between different units in the basin, were identified. Special emphasis is given to the chemical evolution of the epikarstic flow along active gypsum caves and its relation with the main karstic flow in the aquifer. (See also W90-03104) (Author's abstract)
W90-03146

PROTOCOL FOR RELIABLE MONITORING OF GROUNDWATER QUALITY IN KARST TERRANES.
National Park Service, Mammoth Cave, KY.
For primary bibliographic entry see Field 7B.
W90-03147

OUTLINE OF THE UNDERGROUND WATER TRACING IN KARST REGIONS OF CHINA.
Guizhou Inst. of Tech., Guiyang (China). Dept. of Geology.
Z. Mei.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 894-901, 4 fig, 2 ref.

Descriptors: *Tracers, *Tracking techniques, *Karst hydrology, *China, Groundwater movement, Dyes, Ion transport, Conductivity, Resistivity, Microbiological studies, Radioactive tracers, Radon radioisotopes, Tritium, Iodine radioisotopes.

The tracing technique for karst groundwater in China has been widely used, and great progress in applying these techniques has been made in recent years. Tracing methods may be classified into seven types: (1) Ion tracing, such as Cl(-), NO2(-), NO3(-), I(-), NH4(+), and MoO4(2-); (2) Dye tracing, the most useful of which are fluorescine and edible synthetic dyes; (3) Physical tracing--water sounding tracing, geohydrological bomb tracing, electrical conductivity tracing, and resistivity tracing; (4) Particle tracing using lycopodium spore or polystyrene powder; (5) Microbe tracing; (6) Radioisotope tracing--Radon (222-Rn), Tritium (3-H), Iodine (131-I), 51-Cr-EDTA; and (7) Simple and easy tracing techniques including draining water, damming up water, floating, and pumping water. In the past, the results of tracing experiments only indicated the connections between groundwater. Now, however, this data can be used for: (1) analyzing the arrangement of underground streams; (2) calculating the discharge of underground water; and (3) calculating the recovery rate of the tracer according to process curves. (See also W90-03104) (Lantz-PTT)
W90-03148

STUDYING THE RECHARGE BOUNDARY OF A KARST SPRING SYSTEM BY MEANS OF TRACERS.
Institute of Karst Geology, Guilin (China).
W. Chai, A. Dai, G. Yuan, C. Zhao, and P. Bidaux.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 902-909, 3 fig, 4 tab, 3 ref.

Descriptors: *Groundwater recharge, *Karst hydrology, *Tracers, *Geohydrology, *China, Boundaries, Permeability, Hydraulic conductivity, Karst, Chemical analysis, Sinkholes, Zinc chloride, Ammonium molybdate, Groundwater movement, Flow velocity, Surface-groundwater relations, Runoff, Hydrologic budget.

Three kinds of chemical tracers have been used to study the recharge boundary of spring No. 31 system at Guilin karst geohydrological experimental site in China. These tracing tests were conduct-

ed during the rainy season. The tracers were placed into dry sinkholes before the rain and carried underground by surface water after it rained, or placed into sinkholes after the rain and carried into underground by surficial karst water. Both techniques were found to be successful. The experiment shows that zinc chloride and ammonium molybdate are good tracers and should be used in karst areas. Groundwater flow velocity varies greatly from 5 m/hr to 250 m/hr, probably due to different permeabilities and hydraulic gradients in the water-bearing karstic rocks in the zone of aeration. The time-concentration curves of sampling points, mostly the multi-peak type, are generally influenced by the input pulses of rain, and the appearing times of anomalous peak decrease with the increase of rainfall and its intensity. Since runoff in the depression is drained in various directions and at various levels, this must be taken into consideration in the study of water balance. (See also W90-03104) (Lantz-PTT)
W90-03149

GROUNDWATER TRACING AND WATER QUALITY ANALYSIS IN THE VICINITY OF A LANDFILL IN COUNTY MONAGHAN, IRELAND.
Monaghan County Council (Ireland).
B. Mullen, and R. Thorn.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 910-915, 2 fig, 1 tab, 10 ref.

Descriptors: *Path of pollutants, *Karst hydrology, *Groundwater pollution, *Tracers, *Landfills, *Agricultural runoff, *Water pollution sources, *Ireland, Karst, Leachates, Potassium, Sodium.

The effect of a 12-year old landfill receiving domestic, commercial and industrial solid waste on the groundwater quality of a karstified limestone aquifer is described. Water tracing experiments using a variety of tracing agents showed that leachate from the landfill could have polluted nearby wells and springs. Physico-chemical analysis of water samples showed that there was pollution of some water sources but potassium concentrations and potassium/sodium ratios, which are indicative of local, vegetable based pollution, indicated that the source of the pollution was most likely to be runoff from farmyards and not the landfill. (See also W90-03104) (Author's abstract)
W90-03150

PARTICULAR DIFFICULTIES IN DETERMINING HYDRAULIC AND SOLUTE-TRANSPORT PARAMETERS IN CARBONATE ROCKS.
Purdue Univ., Lafayette, IN. Dept. of Earth and Atmospheric Sciences.
D. I. Leap.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists. Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 916-921, 13 ref.

Descriptors: *Path of pollutants, *Karst hydrology, *Field tests, *Groundwater quality, *Water pollution control, *Solute transport, *Hydraulic properties, Pore pressure, Dispersivity, Storativity.

Carbonate rocks, having high secondary porosity and permeability, are often utilized for water supplies, but are exceedingly vulnerable to rapid migration of contaminants. Therefore, it is necessary to know both hydraulic and transport parameters of the aquifers. Field testing methods for determining hydraulic conductivity, storativity and dispersivity require artificial pressure gradients higher or lower than the natural state. Serious error in parameter estimates may occur if the natural pore pressure is already a significant percentage of the overburden pressure. Results of such tests are often questionable--they may or may not represent true values of hydraulic and transport parameters of the unstressed aquifer. (See also W90-03104) (Author's abstract)

W90-03151

B, F AND SR AS TRACERS IN CARBONATE AQUIFERS AND IN KARSTIC GEOTHERMAL SYSTEMS IN ISRAEL.
Geological Survey of Israel, Jerusalem.
A. Arad.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 922-934, 7 fig, 2 tab, 17 ref.

Descriptors: *Karst hydrology, *Geochemistry, *Water chemistry, *Israel, *Boron, *Fluorine, *Strontium, *Tracers, *Geothermal water, Trace elements, Aquifers, Carbonate rocks, Salinity, Groundwater quality, Chlorides, Sodium, Calcium, Saline water intrusion.

A study of trace element distribution in natural groundwater of Israel revealed that B, F and Sr tend to be either correlative with salinity or of consistently high concentration. They rise from a part per billion to a part per million level to become minor constituents with the increase in salinity. Their relations to Cl, Na and Ca as well as their mutual relationship may identify the salinity origin, which is occasionally in question. The division into genetic groups, which generally coincides with geographical distribution, is based on mB/mCl, mF/mCl versus salinity and mSr/mGa, versus mNa/mCl ratios. The water groups defined exhibit various salinities, each indicative of the processes involved in their evolution, namely dissolution, flushing, evaporation, or of a geothermal origin. The latter is evident in the northern part of the Jordan-Dead Sea Rift Valley in the Lake Tiberias region. An exceptional F enrichment in fresh thermal carbonate aquifers indicates equilibrium solubility through temperature-controlled process. (See also W90-03104) (Author's abstract)
W90-03152

ENVIRONMENTAL AND ARTIFICIAL TRACER STUDIES IN AN ALPINE KARST MASSIF (AUSTRIA).
Institute for Geothermics and Hydrogeology, Graz, Austria.
R. Benischke, H. Zojer, P. Fritz, P. Malosszewski, and W. Stichler.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 938-947, 4 fig, 1 tab, 4 ref.

Descriptors: *Tracers, *Environmental tracers, *Geohydrology, *Karst hydrology, *Austria, Karst, Alpine regions, Tritium, Oxygen radioisotopes, Groundwater movement, Flow profiles, Groundwater recharge.

The Hollengebirge (Northern Limestone Alps, Austria), a closed karst massif between two Austrian lakes, was the object of a long-term geohydrological study to determine its water balance, to describe the storage capacity of individual lithologic units and to establish concepts for future exploitation. Hydrographic data were collected from a network of seven stations with recording gages and four precipitation stations. In addition, individual flow measurements were made from larger streams. Environmental isotope measurements (3-H and 18-O) and chemical analyses were carried out on samples from eleven springs during an observation period of two years. As in heavily karstified areas, the discharge varies very strongly with time, the classical flow models for steady state conditions are not applicable and a model for systems with variable flow was used to estimate mean transit times and storage capacities in different rock units. Average altitude of recharge was determined via a time series of analysis of 18-O-contents of spring water. Hydrochemical and dye tracer investigations permit determination of residence time and storage capacity. (See also W90-03104) (Author's abstract)

Group 2F—Groundwater

W90-03153

MICROCRUSTACEANS AS BIOINDICATORS IN KARSTIC AQUIFERS: A CASE STUDY IN THE JURA (NEUCHATEL, SWITZERLAND).
Neuchatel Univ. (Switzerland). Center of Hydrology.
P. Moeschler, R. Christe, and I. Muller.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 948-953, 4 fig, 2 tab, 7 ref. Swiss NSF contract 2.911-0.83.

Descriptors: *Bioindicators, *Groundwater movement, *Karst hydrology, *Switzerland, Geohydrology, Crustaceans, Aquifers, Microcrustaceans.

A study, based on the biological responses in six springs of a poorly unified karstic system, the Montagne de Boudry (Neuchatel Jura, Switzerland), confirms the value of aquatic crustaceans as natural indicators of the karstic aquifer. The considerable differences in fauna encountered in the various springs indicates the poor organization of the flows of the studied karst; a group of microcrustaceans, the Syncarids, was used as an indicator of a drainage axis. These results could make geohydrologists aware of the relevance of biological indicators in the study of karstic aquifers. (See also W90-03104) (Author's abstract)
W90-03154

TEMPERATURE LOGS INTERPRETATION FOR THE IDENTIFICATION OF PREFERENTIAL FLOW PATHWAYS IN THE COASTAL CARBONATIC AND KARSTIC AQUIFER OF THE SALENTO PENINSULA (SOUTHERN ITALY).
Bari Univ. (Italy). Ist. di Geologia Applicata e Geotecnia.
L. Tulipano.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 956-961, 3 fig, 3 ref.

Descriptors: *Geothermal water, *Karst, *Saline-freshwater interfaces, *Groundwater movement, *Coastal aquifers, *Salento Peninsula, *Italy, *Water temperature, *Geohydrology, Permeability, Aquifers, Saline water intrusion, Geothermal water.

The main aquifer of the Salento peninsula occurs in Cretaceous limestone-dolomitic limestones and shows variable permeability due to fracturing and karst processes. The fresh waters float on the seawaters intruding the land mass and outflow toward the sea. In this type of strongly anisotropic aquifer the temperature of groundwaters can be considered as a good tracer. The temperature data can provide information on geohydrological circuits and on the different mobility of groundwaters, assuming that all the possible factors controlling the distribution of temperature in subsurface are taken into account. Based on this premise, the horizontal and vertical trends of isogeothermal surfaces were reconstructed and interpreted by correlating the temperature logs carried out along the water columns of the drilled wells. (See also W90-03104) (Author's abstract)
W90-03155

COMBINED TRACER EXPERIMENTS--AN IMPORTANT TOOL FOR THE DETERMINATION OF THE SORPTION CAPABILITY OF A KARST AQUIFER.
Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). Dept. of Hydrology.
P. Hacker.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 962-967, 1 fig, 2 ref.

Descriptors: *Path of pollutants, *Tracers, *Karst hydrology, *Aquifers, *Sorption, *Groundwater movement, Geohydrology, Case studies, Seepage, Flow velocity, Austria, Geochemistry.

Combined tracer experiments, an already frequently applied method for the determination of flow parameters in rocks and unconsolidated sediments, becomes more important for water supplies or geotechnical engineering when questions arise about how fast liquids or other contaminants are spreading, or if there is a chance for their sorption. To find an answer, more information on the specific attributes of the simple tracer (such as: seepage time, time of first reemergence (maximum flow velocity), spatial distribution, dimensions of the effective aquifer caverns, and minerological and geochemical composition of the aquifer) has to be worked out. A practical example based on a comprehensive karst-hydrological survey in an Austrian sub-alpine mountain range, illustrates how this information can be gathered. (See also W90-03104) (Lantz-PTT)
W90-03156

ASSESSMENT OF KARST GEOTHERMAL RESOURCES OF THE NORTH CHINA BASIN.
Ministry of Geology and Mineral Resources, Beijing (China). Bureau of Hydrogeology and Engineering Geology.
Z. Zhang.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 968-974, 2 fig, 3 tab, 6 ref.

Descriptors: *Geothermal water, *Karst hydrology, *China, Water temperature, Groundwater quality, Groundwater recharge, Geothermal resources.

Most karst geothermal resources occur in areas of concealed uplift in the North China Basin. The temperature of the deep reservoir ranges from 70-150 C as estimated with Na-Li, Na-K-Ca and SiO2 geothermometers. The beneficial energy of this reservoir, assessed using the radial inflow recharge model, equals 440 million tons of standard coal. Therefore, these karst geothermal resources have favorable prospects for exploitation in the future. (See also W90-03104) (Author's abstract)
W90-03157

KARST THERMAL MINERAL WATER RESOURCES AND THEIR MEDICINAL EFFECTS.
Nanjing Hydrogeology and Engineering Geology Party, Sichuan Bureau of Geology and Mineral Resources, China.
K. Tan, and B. Jiang.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 975-982, 3 fig, 1 ref.

Descriptors: *Karst, *Geothermal water, *Mineral water, *Medicinal springs, *China, Gypsum, Water temperature, Springs.

May thermal calcium sulfate mineral springs occur in the Chongqing area, and are known as 'gypsum springs'. These springs outcrop mainly in the karstified axial parts of anticlines in the East Sichuan Folded Zones. Topographically, they tend to represent river valleys criss-crossing the axial parts of the anticlines. The maximum temperature of these springs is 62 C (Tongjing Ts hole). The minimum temperature is 25 C (Jiangjin). The discharges of the natural springs generally are 1000-2000 cu m/d, with the highest discharge up to 4785 cu m/d (at Beiquan spring). On the basis of medical research, the major medicinal functions of the mineral springs lie in: (1) improvement of blood circulation; (2) protecting new granulation growth; (3) softening scars; and (4) relaxing pains. Therefore, mineral spring water has curative effects for the following conditions: varieties of arthritis, rheuma-

tism, neuritis sequelae to injury, gynecology, and skin disorders. (See also W90-03104) (Lantz-PTT)
W90-03158

CHARACTERISTICS AND RESOURCE ASSESSMENT OF THE THERMAL GROUNDWATER FROM THE LOWER TRIASSIC SERIES KARST IN CHONGQING XIAOQUAN HOTEL AREA.
Nanjiang Hydrogeological and Engineering Geological Party, Sichuan, China.
X. Luo, H. Li, B. Jiang, D. Lu, and W. Xu.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 983-991, 7 fig.

Descriptors: *Karst, *Groundwater management, *Groundwater budget, *Geothermal water, *China, Springs, Groundwater movement, Mathematical studies.

The Xiaoquan Hotel is situated in an area of attractive scenery--the southern hot spring region of Chongqing City, China. The thermal groundwater outcrops from the Huaxi River passing through the Nanwenquan anticline. The discharge of the spring has gradually decreased in recent years (only 1.2 L/s), with water temperature decreases of about 30 C. This far from meets the needs of the developing tourist trade. The geothermal and thermal water resources have been evaluated in the district. It is recommended that the exploitation of thermal water be conducted in two of the wells simultaneously, with the volume of exploitable water resources and drawdown in each of the two wells being calculated using different methods, separately. (See also W90-03104) (Lantz-PTT)
W90-03159

FISSURED AQUIFEROUS KNOWLEDGE: TRUMPS AGAINST POLLUTION.
Lille-1 Univ., Villeneuve d'Ascq (France). Lab. de Geologie Appliquee.
E. Carlier, and N. Crampon.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 995-999, 11 ref.

Descriptors: *Karst hydrology, *Path of pollutants, *Fissure water, *Aquifers, *Groundwater pollution, *Groundwater quality, Fracture hydraulics, Mathematical equations, Water quality control, Dispersivity, Hydraulic properties.

A method for studying fissured aquifers is proposed. It is first necessary to determine the geometric parameters of the fractures (direction, frequency and aperture), enabling the hydraulic conductivity tensor and underground flow directions to be computed. This information is fundamental for pollution propagation studies, and, therefore, for spring and drilling protection. The results of transport equations are frequently not in agreement with experimental results; this difference can be explained by a gradual diminution of the aperture of the fractures with depth. A simulation of this phenomenon showed a linear variation of the dispersivity as a function of closing angle, and also, as a function of the injection time of the tracer. New dispersion equations are presented which use parameters which seem to be independent of hydraulic data. (See also W90-03104) (Lantz-PTT)
W90-03160

REGIME OF THE QUALITY OF KARST GROUND WATERS IN EASTERN SERBIA--YUGOSLAVIA.
Belgrade Univ. (Yugoslavia). Faculty of Mining and Geology.
For primary bibliographic entry see Field 5B.
W90-03161

U.S. ENVIRONMENTAL PROTECTION AGEN-CY'S STRATEGY FOR GROUND WATER QUALITY MONITORING AT HAZARDOUS WASTE LAND DISPOSAL FACILITIES LOCATED IN KARST TERRANES.
Environmental Protection Agency, Washington, DC. Office of Research and Development.
M. S. Field.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1006-1011, 11 ref.

Descriptors: *Network design, *Data acquisition, *Karst hydrology, *Path of pollutants, *Groundwater quality, *Monitoring, *Hazardous wastes, Land disposal, Karst, Wells, Groundwater movement, Case studies, Tracers, Sinkholes, Geohydrology, Puerto Rico, Groundwater pollution, Water quality control.

Groundwater monitoring of hazardous waste land disposal units by a network of wells is ineffective when located in karstic terrains. The U.S. EPA is currently proposing to modify its current groundwater quality monitoring requirement of one upgradient well and three downgradient wells for disposal units located in karstic terrains. The convergent nature of subsurface flow to cave streams in karstic terrains requires that effective monitoring wells intercept the cave streams. Wells located around a hazardous waste disposal unit, but not in the specific cave stream draining the site, are only providing irrelevant data and a false sense of security because the water samples from such wells are not necessarily from the hazardous waste disposal unit. A case study of a site in Puerto Rico near the town of Barceloneta is provided in this paper. EPA is drafting a guidance document that will allow monitoring by wells, only if the up and downgradient wells can be demonstrated to be hydraulically connected by means of dye-trace studies. If not, then the monitoring of springs shown to be hydraulically connected to the facility by dye-tracing studies would be required. Monitoring for sinkhole development will also be required to provide advance warning of sinkhole collapse. The investigation and determination of the probability of sinkhole collapse will be given special treatment. (See also W90-03104) (Author's abstract)
W90-03162

DUAL-POROSITY MEDIUM MODEL OF CONTAMINANT TRANSPORT AND ITS APPLICATION IN A KARST AQUIFER IN JINAN.
Changchun Coll. of Geology (China).
For primary bibliographic entry see Field 5B.
W90-03163

EXAMINATION OF ORGANIC SELF-PURIFICATION OF KARST UNDERGROUND WATERCOURSES ON THE EXPERIMENTAL PROVING GROUND IN EAST HERZEGOVINA.
Andrija Stampar School of Public Health, Zagreb (Yugoslavia).
N. Preka, and N. Preka-Lipold.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1022-1027, 2 fig, 5 ref.

Descriptors: *Fate of pollutants, *Path of pollutants, *Self-purification, *Water pollution sources, *Groundwater quality, *Karst hydrology, *Yugoslavia, Wastewater pollution, Flow velocity, Water temperature, Dissolved oxygen.

The results of an examination of the organic self-purification process of karst underground streams on an experimental proving ground, located in east Herzegovina, Yugoslavia, is discussed. Examinations have been made three times, involving waters corresponding to low, medium and high water flows. A system consisting of inlet in the form of one sinkhole and outlet in the form of a potent

karst spring, has been selected for the determination of organic load variations. Pollution load is represented by the wastewaters of a neighboring settlement whose sewage system is discharged into the inlet sinkhole. The time for this pollution flow was determined using markers. Examinations made, indicate that a medium value for the oxygen consumption speed coefficient is K sub 1(r) = 0.117 at underground water temperatures (T) of 10 C, while the average value at T = 20 C is K sub 1(r) = 0.184. With this value for the deoxidation coefficient of an underground stream, and a temperature of 10 C, the present decomposition rate of organic matter is 23.4% per day, i.e., the time of half-disintegration is reached after 2.57 days. (See also W90-03104) (Author's abstract)
W90-03164

OCCURRENCE OF WATER QUALITY REGIME TYPES DURING THE EXPLOITATION OF KARST WATER RESOURCES IN COASTAL REGIONS AND THE MECHANISM OF THEIR FORMATION.
The No. 1 Hydrogeology and Engineering Geology Party of Liaoning Province, China.
D. Li.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1028-1036, 9 fig.

Descriptors: *Groundwater quality, *China, *Water chemistry, *Geochemistry, *Water resources development, *Karst hydrology, *Coastal aquifers, *Saline water intrusion, Water quality, Mixing, Karst.

During long-term monitoring of groundwater in a coastal karst region in China, five types of water quality regimes were identified: (1) intercepted, (2) detour, (3) induced, (4) recoverable, and (5) irrecoverable. A preliminary analysis was performed of the formation mechanism for each type. Judging from the occurrence of recoverable, irrecoverable and other water quality regime types in the coastal karst water exploitation area, it is believed that karst groundwater deteriorates under two kinds of contact relationships between fresh and salt water: the mixed, and the invaded. Once water deterioration begins during the exploitation of karst water, observations of the water quality regime in the downstream exploiting wells must be conducted to find out the contact relations between fresh and salt water. If water quality deterioration is caused by salt water invasion, the water quality regime type must be irrecoverable, and the water quality is permanently damaged. If the water quality deterioration is caused by the addition of salt water, the water quality regime type must be recoverable, where the water quality is only temporarily deteriorated. In order for the water quality to recover as quickly as possible, the groundwater in the downstream wells should be exploited. Study of the intercepted water quality regime type must be combined with investigations on the detour water quality regime type. In order to exploit coastal karst water using the intercepted flow method, precise locations of intercepting wells must be known. The occurrence of some water quality regime types during the exploitation of groundwater, such as the detour and induced water quality regimes, must be related to the mixed contact relationship between salt and fresh water. (See also W90-03104) (Lantz-PTT)
W90-03165

HEAVY METALS AS INDICATORS OF WATER RELATIONS IN KARST AND PROTECTION PROBLEMS.
Titograd Univ. (Yugoslavia). Inst. of Medicine.
For primary bibliographic entry see Field 5B.
W90-03166

POINT SOURCE POLLUTION IN KARST AREAS IN IRELAND.
Geological Survey of Ireland, Dublin.
For primary bibliographic entry see Field 5B.
W90-03167

GROUNDWATER VULNERABILITY IN SOME KARST AREAS OF HYBLEAN FORELAND (SE SICILY).
Catania Univ. (Italy). Ist. di Scienza della Terra.
V. Ferrara.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1053-1058, 3 fig, 3 ref.

Descriptors: *Karst, *Groundwater quality, *Karst hydrology, *Sicily, *Groundwater pollution, *Water pollution sources, Water quality, Stratigraphy, Geohydrology, Aquifers.

The Hyblean foreland is formed from a carbonate horst with a NE-SW alignment. The stratigraphic succession consists of a thick sequence, mainly of carbonates, ranging in age from Upper Triassic to Quaternary, with volcanic horizons intercalated at several distinct times. This region has been exposed to long periods of mechanical and solutional erosion. Surface streams have cut fairly deep valleys, producing a locally rugged topography. Water infiltrates readily into fractures in the rock that have been enlarged by solution. Through these solution openings and caverns, water moves readily and discharges in valleys or in the sea, often as springs. These karstic features provide ready access to the groundwater for effluent disposal, threatening not only the water supplies for rural dwellers, but also the municipal water supply. General investigations of the karstic geohydrology indicates that in some areas of the eastern and southern side of the Hyblean Plateau a direct correlation between groundwater and sources of pollution exist. The vulnerability of the carbonate aquifer is controlled by the development of underground karst canalization, especially in the upper part of the sequence. (See also W90-03104) (Author's abstract)
W90-03168

GROUND-WATER PROTECTION IN THE UNITED STATES.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 5G.
W90-03169

KARST GROUNDWATER INRUSH AND ITS PREVENTION AND CONTROL IN COAL MINES IN CHINA.
Institute of Geology and Exploration, Xian (China).
J. Li, and W. Zhou.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1075-1082, 4 fig.

Descriptors: *Mine drainage, *Karst hydrology, *Groundwater movement, *Coal mines, China, Flow regulators, Flow system.

Karst water inrush in the coal mines of China is frequent and in very large amounts. In order to prevent disasters from this inrush, various methods have been used, according to different natural environmental, economical and technological situations, to reduce the damage caused by inrush, strengthen prevention capability, save drainage costs, and protect the ecological environment of coal mines. These methods include: (1) investigate the occurrence, storage and runoff of karst water, predict the passageway through which water flows into pits, as well as the positions where inrush will occur; (2) drain the karst water; (3) develop a comprehensive prevention and control method against karst water inrush; (4) establish underground, heavy curtains to block the karst water flow; and (5) try to combine the mine drainage with water supply and turn the disastrous in rush water into a usable water resource. (See also W90-03104) (Lantz-PTT)
W90-03171

INTERACTIONS BETWEEN PB-ZN MINE OF GUTTURU PALA AND LOCAL GROUNDWATER RESOURCES (FLUMINESE, SARDINIA, ITALY).
Dept. Georisorse e Territorio, Torino, Italy.
For primary bibliographic entry see Field 4C.
W90-03172

BASIC HYDROGEOLOGICAL CHARACTERISTICS OF KARST-WATER INFILLED MINERAL DEPOSITS AND THE HAZARD PREVENTION, CONTROL AND UTILIZATION OF KARST WATER IN CHINA.
Zhengding Inst. of Hydrogeology and Engineering Geology (China).
Q. Liu.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1089-1096.

Descriptors: *Water pollution sources, *Water pollution control, *Mine wastes, *Geohydrology, *Karst hydrology, *Mineralization, *Groundwater quality, *China, Karst, Classification, Caves, Aquifers, Minerals, Geochemistry.

Mineral deposits infilled with karst water are defined as deposits which while mining, are invaded by karstic water. Subterranean river and conduit systems can also be encountered in some places. Mineral deposits with karst water can be classified according to the space configuration of karst aquifers into three types: (1) Mineral deposits with karst fissure water which is contained mainly within the karst fissure system. This kind of deposit is distributed to the north of the Qinling–Huaihe region, and found in the Carboniferous coal fields, bauxite and skarn-iron deposits, and limestones; (2) Mineral deposits with karst cavern water which is accommodated by karst caverns from 0.5 to 3 m in diameter, connected by fissures. These deposits are distributed mainly in South China, south of Qinling–Huaihe, and found in the Permian coal and the Tertiary lignite fields, the multimetal ore zones of the middle and lower reaches of the Yangtze River and Nanling area, the multimetal ore deposits in Yunnan, Guizhou, Sichuan and the southern Guangdong; and (3) Mineral deposits with a subterranean river and conduit systems, found in coal fields and sulfide-iron deposits southeast of Sichuan, some coal fields in Guizhou and some metal ore deposits in the Guangxi Autonomous Region and Hunan Province. (See also W90-03104) (Lantz-PTT)
W90-03173

MINING DRAINAGE OF A KARSTIC AQUIFER AND THE RELATED PROTECTION PROBLEMS (OLKUSZ MINING DISTRICT, POLAND).
Academy of Mining and Metallurgy, Krakow (Poland). Inst. of Hydrogeology and Engineering Geology.
A. F. Adamczyk, J. Motyka, Z. Wilk, and S. Witczak.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1097-1104, 2 fig, 9 ref.

Descriptors: *Karst hydrology, *Water pollution control, *Mine drainage, *Groundwater pollution, *Water pollution sources, *Poland, Aquifers, Groundwater movement, Zinc, Lead, Pulp and paper industry, Sulfates, Heavy metals.

The Zn-Pb ore deposits in the karst-fissured Triassic rocks of the Olkusz Mining District, Poland, have been exploited for several centuries. During the last hundred years, the exploitation of the ores was possible only by draining a considerable volume of the massif of the carbonate Triassic rocks, part of an underground reservoir flow network. Due to this lowering of the water table by 60-150 m, a widespread depression cone has formed around the surrounding mines and water intakes. The cone covers an area of over 500 sq

km. Another effect of this drainage is that the natural direction of groundwater flow became reversed, and pollutants from different sources have penetrated into the Triassic aquifer. The most dangerous source of this pollution is the liquid wastes from a paper factory which contaminated over 30% of the volume of water flowing into the Zn-Pb ore mines (i.e., more than 1.5 cu m/s). Less important sources of pollution are the water infiltrating from the stacking yards for post-flotation wastes, carrying great amounts of heavy metals and sulfates, as well as liquid wastes and chemicals from leaking sewage pipes and disposal ditches. (See also W90-03104) (Lantz-PTT)
W90-03174

KARST WATER-BEARING SALIENT FEATURES IN WANGFENG COLLIERY, JIAOZUO COAL MINE.
Jiaozuo Coal Mine Administration (China).
Y. Xia.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1105-1111, 4 fig.

Descriptors: *Karst hydrology, *Mine drainage, *Groundwater movement, *China, *Coal mine effects, Jiaozuo, Karst, Geohydrology.

The Jiaozuo Coalfield is a famous mining area in China; within this coalfield, there is much groundwater. The basement of the coal deposit is composed of Cambrian and Ordovician karst limestone with a thickness of about 1,000 m. The total water drainage of the productive mines is 450-500 cu m/min., where over 800 flash floods have taken place. This karstified area can be divided into four geohydrological districts according to comprehensive analyses of prospecting information, pumping tests, structural features, mine discharge, and gas discharge in the coal seam. These are: (1) the western district, where the karst is well developed with abundant water replenishment. It covers 1.8 sq km with a mine discharge of 70 cu m/min (82% of the whole mine); (2) the eastern district, a water-poor area with less developed karst, within an area of 2.6 sq km and a discharge of 3-6 cu m/min making up about 5% of the total water discharge in the mine; (3) the north district, characterized by well developed faults. This district is located in a water-poor area of one square kilometer; and (4) the southern district, a medium water bearing area with developed fissures and few karst caves. It occupies 0.6 sq km, with a water discharge of 10-12 cu m/min, making up about 14% of the total water discharge in the mine. (See also W90-03104) (Lantz-PTT)
W90-03175

STUDY ON THE FORMATION OF TRIASSIC 'GYPSUM-DISSOLVED-STRATA' IN GUIZHOU PROVINCE AND THE SEEPAGE PREVENTION FOR RESERVOIRS.
Water Conservancy and Hydropower Survey and Design Inst. of Guizhou Province, Guiyang (China).
For primary bibliographic entry see Field 8E.
W90-03176

STUDY OF GEOTHERMAL FIELD AND KARSTIC LEAKAGE IN KARSTIC AREA.
Guiyang Hydroelectric Inst. and Investigation (China).
For primary bibliographic entry see Field 8E.
W90-03177

CHARACTERISTICS OF KARST HYDROGEOLOGY AND LEAKAGE OF NIUKOUYU RESERVOIR IN BEIJING.
Institute of Geography, Kunming (China).
L. Song, J. Fang, and C. Wang.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1136-1144, 1

fig, 1 tab.

Descriptors: *Geohydrology, *China, *Dam effects, *Reservoirs, *Leakage, *Karst hydrology, Beijing, Niukouyu Reservoir, Aquifers, Karst, Groundwater movement.

Characteristics of the limestone aquifer in the Niukouyu area of China are controlled predominantly by the evolution process of Niukouyu polje. This karstification is very strong in the zone 5-10 m below the limestone surface. Owing to the red clay which fills in the karstic fissures, the capacity of storage and transmissivity have been greatly reduced. The lower part of the aquifer, under a depth of 10 m, is characterized by solutional fissures. Water levels and circulation was studied in seven boreholes, the Mabav spring and the Niukouyu Reservoir. There is shallow phreatic flow circulation which is seriously affected by the reservoir. In the 2nd and 3rd dam area, the Ordovician limestone aquifer and mid-Upper Cambrian limestone aquifer belong to two different geohydrological units. Reservoir water leaks through the fractures in the limestone and through badly sealed boreholes. The main leakage zone is the Mabao spring, and the 4th dam foundation. (See also W90-03104) (Lantz-PTT)
W90-03178

CAN WATER LOSSES FROM RESERVOIRS IN KARST BE PREDICTED.
Karlova Univ., Prague (Czechoslovakia). Dept. of Hydrogeology and Engineering Geology.
J. Silar.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1148-1152.

Descriptors: *Dam effects, *Leakage, *Water loss, *Reservoirs, *Groundwater movement, *Hydrologic budget, *Karst hydrology, Hydroelectric plants, Reservoir construction, Water level, Leakage.

The prediction of leakage from reservoirs and the estimation of its economic consequences becomes significant when designing water power systems. Future water losses may be estimated by investigating their specific indications through: (1) The relationship between geomorphological evolution and the geohydrological structure; (2) the morphology of the surroundings of the reservoir; (3) the phenomena indicating karst groundwater flow; and (4) the hydrologic balance of the river. Water losses which occur after the impoundment of a reservoir are indicated by: the hydrological balance of the reservoir, the fall of the reservoir level, the origin of swallow holes in the reservoir, and the phenomena indicating water flow from the reservoir into the surroundings. To avoid ambiguous results, geohydrological investigations must cover the larger surroundings of the reservoir. Hydrological monitoring has to start well in advance of construction and has to continue after the reservoir has been impounded. (See also W90-03104) (Author's abstract)
W90-03179

ALMOST DEVELOPED TECHNIQUE OF KARST COLLAPSE PREVENTION DURING MINE DRAINAGE.
China Univ. of Geosciences, Beijing, China.
K. Tian.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1155-1162, 5 fig, 3 ref.

Descriptors: *Mining engineering, *Subsidence, *Groundwater mining, *Geohydrology, *Mine drainage, *Karst hydrology, Fracture permeability, Double level flow, Groundwater movement, Karst, Aquifers, Flow pattern.

In regions covered with karst, when the limestone aquifer is thick enough for the fracture permeability ellipsoid to transform from upright to horizontal, and the geohydrologic open-degree of a limestone aquifer at a certain depth (S) is buried in a closed environment, mine production should drain off the aquifer by abstracting groundwater. Initially this should be done at a depth below S. This way, surface collapses in the mine district can be prevented after an artificial 'double level flow' is formed in the aquifer. This flow prevents the violent contradiction between water supply and mine dewatering. (See also W90-03104) (Lantz-PTT)
W90-03180

INVENTORY OF SINKHOLES AND RELATED KARST FEATURES IN THE COMMONWEALTH OF PENNSYLVANIA, USA.
Pennsylvania Dept. of Environmental Resources, Harrisburg. Bureau of Topographic and Geologic Survey.
W. E. Kochanov.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1163-1168, 3 fig, 4 ref.

Descriptors: *Sinkholes, *Karst, *Data collections, *Databases, *Pennsylvania, *Data storage and retrieval, Urban areas, Aerial photography, Geohydrology, History.

Areas of projected urban growth are the focus of a number of projects in Pennsylvania dealing with assessing the impact of environmental planning on the geologic environment. The sinkhole inventory program is a state-wide effort to define areas of carbonate bedrock prone to sinkhole development. The program is designed to include data collection, establishing a data base, and data access. Aerial photographs are used initially to identify karst areas of the state. Historical data on sinkhole occurrence is obtained from various governing groups and individuals. The data obtained from all sources are numerically coded and entered into a computer to establish a usable database. Geologic maps are used to supplement the data for locating karst subsidence features. The data is distributed as an open-file report. With more advanced computer software, mapping capabilities can be incorporated into the database allowing more detailed analyses of regional karst problems. (See also W90-03104) (Author's abstract)
W90-03181

EVALUATION AND PREDICTION OF KARST COLLAPSE--AS EXEMPLIFIED BY THE DAGUANGSHAN IRON MINE.
Institute of Karst Geology, Guilin (China).
For primary bibliographic entry see Field 7C.
W90-03182

SURFACE COLLAPSE IN KARST REGIONS.
Guilin Coll. of Geology (China).
For primary bibliographic entry see Field 8E.
W90-03183

FORMATION OF GYPSUM KARST COLLAPSE-COLUMN AND ITS HYDROGEOLOGICAL SIGNIFICANCE.
State Bureau of Mineral Reserves, Beijing (China).
X. Qian.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1186-1193, 1 fig, 5 ref.

Descriptors: *Subsidence, *Geohydrology, *Collapse columns, *Karst hydrology, *Gypsum, *Groundwater recharge, Groundwater movement, Coal mines, China, Groundwater storage.

The study of the formation of gypsum karst collapse columns is of great importance to both karstology and national economic construction.

Having been hydrated, thick anhydrite tends to greatly expand to form gypsum. The powerful force of crystallization make the gypsum move slowly into the vulnerable parts of the overlying strata. There, the solution of gypsum by underground water cause the surrounding rocks to collapse. In coal fields where collapse columns are developed, exploration drill holes must be kept off the collapse columns. The existence of collapse columns may also cause trouble in the digging and support of galleries. Although collapse columns are less permeable, the surrounding rocks are broken and strongly pervious; they may be regarded as a potential source of water invasion into the galleries. In the Tongye Mine of Anyang, Henan Province, China, water rich collapse columns with a maximum discharge of 0.42 cu m/sec were found. In 1984, in the Fangezhuang Coal Field, Tangshan Coal Mine, confined karst water coming from the deep Ordovician rocks poured through the peripheries of collapse columns into the galleries. The maximum discharge was 12 cu m/sec and the total amount of water which flowed in for three months reached 46,000,000 cu m. In mountainous limestone areas, the underground water level may be at a depth of > 500 m. Relatively large collapse columns containing debris are less permeable, and may have a small amount of underground water stored, which can be used as a source of drinking water. Since the peripheries of collapse columns are highly permeable, river water percolates into the collapse columns when passing through. This percolation is a primary source of natural recharge to large karst springs, and acts as an important channel for the artificial recharge of springs as well. (See also W90-03104) (Lantz-PTT)
W90-03184

GEOMORPHOLOGICAL APPROACH TO ENGINEERING IN KARST.
Bergen Univ. (Norway). Dept. of Geology.
S. E. Lauritzen.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1194-1199, 2 fig, 11 ref.

Descriptors: *Construction, *Aquifers, *Karst hydrology, *Geomorphology, *Groundwater storage, Regression analysis, Hydroelectric plants, Tunnels, Regression analysis, Geophysics, Porosity, Groundwater movement, Cavern flow.

Detection and evaluation of subsurface voids is critical for technical developments in karst. Geomorphological analysis (fracture pattern, tectonics, cave morphometry, water tracing and recession analysis) is the 'ground truth' for traditional geophysical interpretation. A projected hydroelectric tunnel through a small marble aquifer in northern Norway is discussed using these methods. The upper 40-50 m of the karst have an average cave conduit porosity exceeding 1-2% of the total volume. Total dynamic storage volumes in the phreatic zone are about 40,000 cu m, and the extrapolated depth of karstification is 75-100 m. Water-filled annex chambers of about 130 cu m were demonstrated by cave diving. The projected tunnel was not recommended by this analysis. (See also W90-03104) (Author's abstract)
W90-03185

ANALYSIS OF THE MECHANISM OF THE SURFACE COLLAPSE IN REGIONS OF CONCEALED KARST AND CASE STUDIES OF THE FOUNDATION TREATMENT FOR BUILDINGS.
Comprehensive Investigation and Surveying Inst., EIM, China.
C. Chen.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1200-1208, 8 fig.

Descriptors: *Construction, *Subsidence, *China, *Geohydrology, *Case studies, *Karst hydrology,

*Structural engineering, Structural damage, Groundwater movement, Karst, Water level decline, Foundation failure, Soil transport.

Concealed karst is widespread over 21 provinces in China. Due to the water fluctuation caused by intense drawoff of groundwater, surface deformation, cracks and collapses are induced, bringing about the damage of buildings, traffic stoppage, shutdown of mines, and water pollution. The internal cause of this kind of collapse is the existence of soluble rocks where cracks and karst caves develop, and above which there exist loose soils having connection with karst water. The external cause is a rapid change in the water table. In loose soils, the natural hydraulic gradient is < 0.005 where water can hardly carry soil particles, while water in karst fractures has a more rapid speed of 160-180 m/day. When water flows down to the bottom of loose soils, the velocity increases suddenly, soon exceeding the critical value of the suffusion capacity, allowing soil particles to be carried away. During this drop in the water level, a negative presure can form causing vacuum suction which in turn results in collapse. Two case studies are discussed which present engineering methods which can be utilized to help prevent the kind of structural damage which can result from this type of surface collapse. (See also W90-03104) (Lantz-PTT)
W90-03186

HYDROGEOLOGIC FACTORS ASSOCIATED WITH RECENT DOLINE DEVELOPMENT IN THE ORLANDO AREA, FLORIDA 32816.
Florida Sinkhole Research Inst., Orlando.
W. L. Wilson, and B. F. Beck.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1212-1217, 3 fig, 6 ref.

Descriptors: *Subsidence, *Geohydrology, *Sinkholes, *Karst hydrology, *Florida, Orlando, Karst, Groundwater movement, Groundwater recharge, Potentiometric level, Aerial photography, Aquifers.

The city of Orlando and its surrounding environs are situated on an active, thickly-mantled, karst area. On the average, 11 dolines collapse each year, and many damage buildings, roads, and other property. Eighty-five percent of the new dolines occur in high recharge areas. Low potentiometric elevations in the limestone aquifer coincide with more frequent doline development. New dolines occur most frequently at sites where the overburden has an intermediate thickness. No statistically significant relationship was found between the location of new dolines and either high or low altitude photo linears. (See also W90-03104) (Author's abstract)
W90-03187

SOME EXPERIENCES IN COMPILING HYDROGEOLOGICAL MAPS OF KARSTIC TERRAINS IN CHINA.
Ministry of Geology and Mineral Resources, Beijing (China). Advisory Committee on Geology Science and Technology.
For primary bibliographic entry see Field 7C.
W90-03188

HYDROGEOLOGICAL MAPPING AND THE USE OF REMOTE SENSING TECHNIQUE IN THE KARST AREAS OF BOHEMIAN MASSIF.
Ustredni Ustav Geologicky, Prague (Czechoslovakia).
For primary bibliographic entry see Field 7C.
W90-03189

PARTICULARITIES OF GROUND-WATER RUNOFF GENERATION IN KARST REGIONS IN EUROPE.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
R. G. Dzhamalov, I. V. Diordiev, N. A. Lebedeva,

and T. I. Safronova.
IN: Karst Hydrogeology and Karst Environment
Protection. Volume 2. Proceedings of the 21st
Congress of the International Association of Hy-
drogeologists, Guilin, China, October 10-15, 1988.
IAHS Publication No. 176, (1988). p 1232-1236, 5
ref.

Descriptors: *Groundwater movement, *Europe,
*Groundwater runoff, *Karst hydrology, Karst,
Geohydrology, Mediterranean Sea, Alpine re-
gions.

Based on a regional assessment and mapping of
groundwater runoff, distinctive features of ground-
water runoff generation in European karst regions
are presented. Karst areas are mainly confined to
the Russian platform and mountain-fold structures
of predominantly Alpine orogenesis (Dinaric
Mountains, Alps, Pyrenees, and Carpathians).
Groundwater runoff from karst regions of Europe
was found to increase gradually from north-east to
south-west, ranging broadly in separate areas.
Direct groundwater discharge to the Mediterrane-
an Sea is a substantial inflow component of its
balance. Two thirds of the submarine groundwater
discharge is generated in karst rocks. The peculiar
conditions of groundwater runoff generation in
karst suggest that these groundwater runoff areas
should be considered azonal, not complying with
the found latitudinal zonality in groundwater
runoff distribution on the global scale. (See also
W90-03104)(Lantz-PTT)
W90-03190

**PROPOSAL OF A FORM FOR THE RECORD-
ING OF THE MAIN KARST SPRINGS.**
Padua Univ. (Italy). Dept. of Geography.
For primary bibliographic entry see Field 7C.
W90-03191

**ANALYSIS OF TRENDS IN THE HYDROGEO-
LOGIC CARTOGRAPHY OF KARSTIC TER-
RAINS.**
Zagreb Univ. (Yugoslavia). Inst. of Geology.
For primary bibliographic entry see Field 7C.
W90-03192

**THERMAL WATERS IN GRANITIC TER-
RAINS, CASE HISTORIES FROM POLAND
AND NORTH YEMEN.**
Polish Academy of Sciences, Warsaw. Geological
Sciences Inst.
J. Dowgiallo.
IN: Karst Hydrogeology and Karst Environment
Protection. Volume 2. Proceedings of the 21st
Congress of the International Association of Hy-
drogeologists, Guilin, China, October 10-15, 1988.
IAHS Publication No. 176, (1988). p 1253-1260, 2
fig, 1 tab, 9 ref.

Descriptors: *Geohydrology, *Geothermal water,
*Granites, *Poland, Case studies, Yemen, Urani-
um, Thorium, Hot springs.

Thermal waters occur in the Upper Carboniferous
Karkonosze granite (Western Sudetes) of Poland,
as well as in its Precambrian and Lower Paleozoic
cover. Their temperature, up to 68 C, is not only
due to the depth of circulation, but also to radio-
genic heat production resulting in the decay of
uranium and thorium present in the granites in
considerable amounts. Horizontal fissure systems
found in boreholes up to a depth of 750 m, yield
considerable quantities of thermal water. Hot
springs occurring near the Upper Tertiary granitic
bodies of Manakha-Lihab, Milhan-Hufash and
Bura-Raymah Western Escarpment of North
Yemen, probably owe their temperature, to radio-
genic heat produced in the granites. Drilling may
reveal horizontal relaxation fissures yielding ther-
mal water of economic importance. (See also W90-
03104) (Author's abstract)
W90-03193

**SURFACE AND SUBSURFACE MAPPING IN
HYDROGEOLOGY.**
For primary bibliographic entry see Field 7C.
W90-03199

**POISONED WELL: NEW STRATEGIES FOR
GROUNDWATER PROTECTION.**
For primary bibliographic entry see Field 5G.
W90-03200

**SORPTION OF NONPOLAR ORGANIC
CHEMICALS ON LOW-CARBON-CONTENT
AQUIFER MATERIALS.**
Air Force Engineering and Services Center, Tyn-
dall AFB, FL. Engineering and Services Lab.
For primary bibliographic entry see Field 5B.
W90-03202

STEP-DRAWDOWN DATA ANALYSIS.
National Chiao Tung Univ., Hsinchu (Taiwan).
Dept. of Civil Engineering.
H. Yeh.
Journal of Hydraulic Engineering (ASCE)
JHEND8, Vol. 115, No. 10, p 1426-1432, Oct 1989.
5 tab, 11 ref.

Descriptors: *Aquifer testing, *Pumping tests,
*Step-drawdown tests, *Pump wells, *Drawdown,
*Computer programs, *Data interpretation, Math-
ematical studies, Well hydraulics, Least squares
method, Finite difference methods.

The total drawdown in a pumping well consists of
the formation loss and the well loss. The purpose
of this paper was to present a method which does
not require graphic procedures to analyze the step-
drawdown data. The method is based on a nonlin-
ear least-squares approach and the finite-difference
Newton's method to determine the loss constants
of the aquifer formation and the pumping well. To
obtain a result by this method takes no more than
10 iterations and less than 0.13 central-processing-
unit sec on a CDC-Cyber 170-720 computer. The
proposed method yielded fewer prediction errors
and better fit Todd's step-drawdown data than the
graphic method. The author concluded that this
method produces the fewest statistical errors for
predicted drawdowns at the pumping well and has
the advantages of quick convergence and high
accuracy with initial guesses of formation constant
and well loss constants over a reasonable range.
(Ence-PTT)
W90-03226

**EMERGING LEGAL ISSUES IN GROUND-
WATER CONTAMINATION CASES.**
Huey, Guilday, Kuersteiner and Tucker, Tallahas-
see, FL.
T. J. Guilday, and R. A. DeMeo.
Florida Scientist FLSCAQ, Vol. 52, No. 3, p 183-
160, Summer 1989. 91 ref.

Descriptors: *Legal aspects, *Florida, *Ground-
water pollution, *Drinking water, *Water law,
Water pollution prevention, Liability, Hazardous
wastes, Path of pollutants, State jurisdiction,
Public participation, Administrative regulations,
Waste management, Cleanup.

Legal issues relating to groundwater contamina-
tion in Florida are rapidly changing. The regula-
tors responsible for protecting groundwater are
increasingly more aggressive as scientific tech-
nique reveals the heretofore unknown scope of
contamination caused by hazardous waste, hazard-
ous substances, petroleum products, and pesticides.
The states including Florida and private individ-
uals recently have asserted common law remedies
such as negligence, nuisance, trespass, and indem-
nification to remedy groundwater contamination.
Florida law is undergoing rapid metamorphosis
and existing statutory and common law theories
are being reevaluated. Amendments to the Florida
Safe Drinking Water Act substantially stiffen the
penalties that may be assessed against violators,
and give EPA the authority to enforce regulations
by issuing administrative orders rather than suing
in federal court. Provisions were added to the
Clean Water Act to establish liability for ground-
water contamination. CERCLA (the Comprehen-
sive Environmental Response, Compensation, and
Liability Act) is a liability statute designed to facili-
tate cleanup of facilities where hazardous sub-
stances were released into the environment, and
RCRA (the Resource Conservation and Recovery

act) is a regulatory statute providing for the man-
agement of hazardous waste. Congress and the
Florida Legislature should reexamine the legal
issues and prepare new more meaningful remedies
to groundwater contamination in Florida. (Geiger-
PTT)
W90-03243

**LABORATORY MODELS FOR ASSESSING
THE FATE OF GROUNDWATER CONTAMI-
NANTS.**
Florida Univ., Gainesville. Dept. of Environmental
Engineering Sciences.
For primary bibliographic entry see Field 5B.
W90-03244

**PESTICIDES AND GROUND WATER PRO-
TECTION.**
Florida State Dept. of Environmental Regulation,
Tallahassee. Bureau of Ground Water Protection.
For primary bibliographic entry see Field 5G.
W90-03245

**GROUND-WATER CONTAMINATION PRO-
GRAMS OF THE U.S. GEOLOGICAL SURVEY
IN FLORIDA.**
Geological Survey, Tallahassee, FL. Water Re-
sources Div.
For primary bibliographic entry see Field 5G.
W90-03246

**CAUSES OF SEASONAL VARIATIONS OF
THE SEEPAGE REGIME OF EARTH STRUC-
TURES.**
For primary bibliographic entry see Field 8D.
W90-03252

**NUMERICAL ESTIMATION OF AQUIFER PA-
RAMETERS USING TWO OBSERVATIONAL
WELLS.**
Obafemi Awolowo Univ., Ile-Ife (Nigeria). Dept.
of Geology.
For primary bibliographic entry see Field 7C.
W90-03338

**INTERSTITIAL AND ION-EXCHANGE
WATER IN THE NORTHERN BORDER OF
THE BAVARIAN CALCAREOUS ALPS.**
Technische Univ. Muenchen (Germany, F.R.).
Lehrstuhl fuer Hydrogeologie und Hydrochemie.
M. Baumann, and C. Habereder.
Zeitschrift fuer Wasser - und Abwasser Forschung
ZWABAQ, Vol. 22, No. 3, p 111-118, July 17,
1989. 3 fig, 6 tab, 18 ref. English summary.

Descriptors: *Water chemistry, *Geochemistry,
*Interstitial water, *Ion exchange, *Mineral water,
Groundwater, Iodides.

During prospecting for mineral water within the
northern part of the Bavarian Calcareous Alps in
Garmisch-Partenkirchen and Ruhpolding highly
mineralized types of groundwater containing
iodide were found. This type of deep groundwater
occurring at about 200 m below ground level was
not expected in the calcareous and dolomitic layers
(Triassic, Jurassic). The hydrogeological and hy-
drochemical investigations showed a mixture of
autochthonous groundwater with ascending inter-
stitial water of the lower parts of the Molasse
sediments (Tertiary). Comparing the fractions of
the interstitial (marine) water in the mineral waters
of Ruhpolding and Garmisch-Partenkirchen it was
observed, that this type of water is highly enriched
in the first and affects scarcely the second. The
genesis of the 'Garmischer' water is also strongly
influenced by ion-exchange processes. (Author's
abstract)
W90-03355

**NUMERICAL SPECTRAL APPROACH FOR
THE DERIVATION OF PIEZOMETRIC HEAD
COVARIANCE FUNCTIONS.**
Stanford Univ., CA. Dept. of Civil Engineering.
T. Van Lent, and P. K. Kitanidis.

Water Resources Research WRERAQ, Vol. 25, No. 11, p 2287-2298, November 1989. 8 fig, 30 ref. NSF Grant EET 87-16585 and USGS award 14-08-001-G1491.

Descriptors: *Model studies, *Kriging, *Groundwater movement, *Piezometric head, *Stochastic models, *Numerical analysis, Mathematical models, Fourier-Stieltjes analysis, Permeability.

Relating the variability of permeability to the variability of head is a central part of linear estimation techniques such as cokriging. Only a few analytic relationships between log permeability covariances and head covariances presently exist. A general numerical procedure has been developed which computes head covariances (ordinary or generalized) and cross covariances of any proper log permeability covariance. The numerical spectral method, a discrete analog of Fourier-Stieltjes analysis, employs the pertinent linearized (small-perturbation approximation) equations describing the physics of flow. The domain is taken as finite, with boundary effects considered negligible. The numerical spectral method can reproduce all pertinent analytic results with excellent agreement. The method's generality was demonstrated by finding the covariance relations for a case where no analytical results presently exist. (Author's abstract) W90-03418

MULTISCALE STUDY OF THE PERMEABILITY OF A THICK CLAYEY TILL.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
C. K. Keller, G. van der Kamp, and J. A. Cherry.
Water Resources Research WRERAQ, Vol. 25, No. 11, p 2299-2317, November 1989. 17 fig, 3 tab, 49 ref. Canadian Natural Science and Engineering Research Council Grants G1372 and A8186.

Descriptors: *Till, *Glacial aquifers, *Groundwater movement, *Clays, *Permeability, *Hydraulic conductivity, Water table, Slug tests, Boreholes, Piezometers.

Two previously undocumented methods of bulk permeability (K) determination were evaluated and the results compared with results of conventional smaller-scale tests on the same thick clayey till deposit. Analysis of the downward propagation of seasonal water table fluctuations yielded bulk K of approximately 10 to the minus 10th power m/s, in close agreement with results of laboratory consolidation and permeameter tests, slug tests, and distribution of vertical hydraulic gradient with depth in the deposit. This agreement suggests that for such materials, high-gradient tests conducted at small scales of distance and time can provide reasonable estimates of bulk K. The results also imply groundwater residence times in the till of thousands of years. The flow pattern observed near a large excavation in the till was consistent with the initial recoveries of piezometers installed in much smaller boreholes, assuming perturbation of hydraulic head in the formation due to borehole excavation. Time scales of these perturbations, which prevent interpretation of measured hydraulic head using conventional well hydraulic methods, varied from months to tens of years. (Author's abstract) W90-03419

STOCHASTIC ANALYSIS OF NONSTATIONARY SUBSURFACE SOLUTE TRANSPORT: 2. CONDITIONAL MOMENTS.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B. W90-03421

UNIDIMENSIONAL SOLUTE TRANSPORT INCORPORATING EQUILIBRIUM AND RATE-LIMITED ISOTHERMS WITH FIRST-ORDER LOSS: 3. APPROXIMATE SIMULATIONS OF THE FRONT PROPAGATING AFTER A STEP INPUT.
Department of Scientific and Industrial Research, Lower Hutt (New Zealand). Inst. of Nuclear Sciences.
For primary bibliographic entry see Field 5B.

W90-03422

ANALYSIS OF PULSE INTERFERENCE TESTS.
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 7B. W90-03424

ANALYSIS OF SLUG TESTS IN THE FREQUENCY DOMAIN.
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
P. Marschall, and B. Barczewski.
Water Resources Research WRERAQ, Vol. 25, No. 11, p 2388-2396, November 1989. 8 fig, 13 ref, 2 append.

Descriptors: *Aquifers, *Hydraulic conductivity, *Slug tests, *Aquifer testing, *Pumping tests, *Transmissivity, *Impedance, Mathematical analysis.

A generalized analytical frequency domain method for the evaluation of transmissivity tests is presented. For a confined homogeneous aquifer the Kelvin functions represent a satisfactory set of solutions for the equation of radial flow in the frequency domain. Depending on the type of transmissivity test, simple analytical frequency-dependent transfer functions can be defined, which relate the reaction of the aquifer to any pressure disturbance. Hence a numerical Fourier transform of the field data can be performed to determine a transfer function of data, which can be fitted with the analytical one. In order to estimate the hydraulic parameters a special logarithmic Fourier transform was used to analyze synthetic data of a slug test to verify this approach. The consideration of transmissivity tests in the frequency domain leads to some promising prospects. With this method a radius of penetration for each excitation frequency can be defined. Analytical solutions for radial symmetric permeability distributions are available (e.g., consideration of a gravel pack or a developed zone). The frequency domain approach was also extended to a new type of low-cost transmissivity test, the hydraulic impedance test, which delivers an excellent estimation of aquifer parameters because the pressure disturbance, which has to be produced during the test, can be optimized with respect to the sensitivity of the aquifer response. (Sand-PTT) W90-03425

MODELLING WATER-TABLE MOVEMENT IN FLAT LOW-LYING LANDS.
Silsoe Coll. (England).
E. G. Youngs, P. B. Leeds-Harrison, and J. M. Chapman.
Hydrological Processes HYPRE3, Vol. 3, No. 4, p 301-315, October-December 1989. 8 fig, 20 ref.

Descriptors: *Surface-groundwater relations, *Infiltration, *Water table fluctuations, *Model studies, *Evaporation, *Drainage effects, *Soil water, *Groundwater movement, Aeration zone, Mathematical models, Seasonal variation, Drainage ditches, Rainfall, Hydraulic conductivity.

The unsteady water-table movement caused by intermittent rainfall and varying evaporation in flat lands intersected by a network of ditches was modelled using land-drainage theory. The unsteady water tables were assumed to behave as a continuous succession of steady states with the flux through the water table given by the sum of components due to rainfall and evaporation through the soil surface and due to water released or taken up by the unsaturated soil above the water table. A simple steady-state drainage equation was used for the relationship between water-table height and flux, and the specific yield was assumed to have a constant value. The simulated seasonal water table using estimated hydraulic soil properties and meteorological records for a field site agreed with available dip-well observations. The water table was much lower than the ditch-water level during the summer months. The sensitivity of simulated results to model parameters was demonstrated. Al-

though the use of an exponential hydraulic conductivity relationship, obtained from actual measurement, is a weakness of the model, the difficulty of making measurements of hydraulic conductivity of unsaturated soils would limit the easy application of the model. The model does not describe the soil-water regime above the water table but it does give an estimate of the extent of the groundwater region and therefore the lower boundary of the unsaturated soil-water zone. (Peters-PTT) W90-03499

SIMULATION ANALYSIS OF THE GROUNDWATER SYSTEM IN MESOZOIC ROCKS IN THE FOUR CORNERS AREA, UTAH, COLORADO, ARIZONA, AND NEW MEXICO.
Geological Survey, Salt Lake City, UT. Water Resources Div.
B. E. Thomas.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4086, 1989. 89p, 24 fig, 7 tab, 46 ref.

Descriptors: *Groundwater resources, *Groundwater movement, *Model studies, *Arizona, *Potentiometric level, *Colorado, *New Mexico, Groundwater recharge, Discharge, Colorado River Basin, Utah.

The steady-state groundwater system in Mesozoic rocks in the Four Corners area, Utah, Colorado, Arizona, and New Mexico, was simulated with a finite-difference digital-computer model to improve the understanding of the system. The simulated area is 4,100 sq mi, and it includes three aquifers. The Entrada-Navajo aquifer includes the Wingate, Navajo, and Entrada Sandstones. The Morrison aquifer includes the sandstone units of the Morrison Formation. The Dakota aquifer includes the Burro Canyon Formation and Dakota Sandstone. The simulation of the groundwater system had a mean error (error is absolute value of residual) of 70 ft for the Entrada-Navajo aquifer, 67 ft for the Morrison aquifer and 79 ft for the Dakota aquifer. The hydraulic conductivity used in the simulation ranged from 0.38 to 0.47 ft/day. Simulated inflow to the groundwater system was 30,000 acre-ft/yr. 48% of the inflow is from infiltration of precipitation within the simulated area, and 42% is from infiltration in 145 sq mi of mountain areas adjacent to the simulated area. Simulations indicated that some vertical inflow of water is needed between the Entrada-Navajo and Morrison aquifers to develop a reasonable representation of the system. (USGS) W90-03538

APPROXIMATE ALTITUDE OF WATER LEVELS IN WELLS IN THE CHICOT AND EVANGELINE AQUIFERS IN THE HOUSTON AREA, TEXAS, SPRING 1989.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-03539

SUMMARY OF HYDROLOGIC DATA FOR THE SAN GABRIEL RIVER BASIN AND EDWARDS AQUIFER, GEORGETOWN AREA, TEXAS, WATER YEAR 1988.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-03541

GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1989.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 7C. W90-03543

BIANNUAL WATER-RESOURCES REVIEW, WHITE SANDS MISSILE RANGE, NEW MEXICO, 1986 AND 1987.
Geological Survey, Albuquerque, NM. Water Re-

sources Div.
For primary bibliographic entry see Field 7C.
W90-03544

SIMULATED WATER-LEVEL AND WATER-QUALITY CHANGES IN THE BOLSON-FILL AQUIFER, POST HEADQUARTERS AREA, WHITE SANDS MISSILE RANGE, NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.
D. W. Risser.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4152, July 1989. 71p, 33 fig, 3 tab, 59 ref.

Descriptors: *Model studies, *Water quality, *Geochemistry, *White Sands Missile Range, *New Mexico, *Water resources, Tularosa Basin.

The quantity of freshwater available in the Post Headquarters well field, White Sand Missile Range, New Mexico, is limited and its quality is threatened by saltwater enroachment. A three-dimensional, finite-difference, groundwater flow model and a cross-sectional, density-dependent solute-transport model were constructed to simulate possible future water level declines and water quality changes in the Post Headquarters well field. A six-layer flow model was constructed using hydraulic-conductivity values in the upper 600 ft of saturated aquifer ranging from 0.1 to 10 ft/day, specific yield of 0.15, and average recharge of about 1,590 acre-ft/yr. Water levels simulated by the model closely matched measured water levels for 1948-82. Possible future water level changes for 1983-2017 were simulated using rates of groundwater withdrawal of 1,033 and 2,066 acre-ft/year and wastewater return flow of 0 or 30% of the groundwater withdrawal rate. The cross-sectional solute-transport model indicated that the freshwater zone is about 1,500 to 2,000 ft thick beneath the well field. Transient simulations show that solutes probably will move laterally toward the well field rather than from beneath the well field. (USGS)
W90-03545

2G. Water In Soils

WATER CONTENT DEPENDENCE OF TRAPPED AIR IN TWO SOILS.
Geological Survey, Menlo Park, CA.
D. A. Stonestrom, and J. Rubin.
Water Resources Research WRERAQ, Vol. 25, No. 9, p 1947-1958, September 1989. 8 fig, 2 tab, 40 ref.

Descriptors: *Soil water, *Air-earth interfaces, *Air-water interfaces, *Hydrostatic pressure, *Hysteresis, Aeration zone, Water pressure, Sand, Loam, Soil types, Density, Specific gravity, Hydraulic conductivity, Saturated soils, Retention capacity.

The presence of trapped air has significant consequences for the flow of water through soils: it reduces hydraulic conductivity and influences infiltration rates. An improved air pycnometer method was used to examine the water content dependence of trapped-air volumes in two repacked, nonswelling soils. Trapped-air volumes were determined at a series of hydrostatic equilibrium stages which were attained during water pressure-controlled wetting and drying cycles. Small pressure perturbations were used in the air pycnometer method. Volumes of trapped air obtained at each hydrostatic equilibrium stage were independent of perturbation level and remained relatively constant over the time required to make repeated determinations. The volume fraction of trapped air was found to be a regular, monotonically increasing (though possibly hysteric) function of water content. For the soils studied, the function definitely exceeded zero only at water contents greater than 70% of saturation. However, during the initial drying from complete water saturation, the volume fraction of trapped air was virtually zero. Air trapping influenced the water retention curves significantly only

at water contents higher than about 60% of saturation. Not all of the differences between the initial and the other drying retention curves were accounted for by observed differences in trapped-air volumes. Air trapping was not required for the onset of hysteresis in the water retention relation for the cases studied, i.e., when drying-to-wetting reversals were imposed at about 27% and 40% of saturation for the sand and loam soils, respectively. (Author's abstract)
W90-02584

AIR PERMEABILITY AND TRAPPED-AIR CONTENT IN TWO SOILS.
Geological Survey, Menlo Park, CA.
D. A. Stonestrom, and J. Rubin.
Water Resources Research WRERAQ, Vol. 25, No. 9, p 1959-1969, September 1989. 10 fig, 1 tab, 31 ref.

Descriptors: *Soil porosity, *Hysteresis, *Permeability, *Soil water, *Pores, Pore pressure, Darcys law, Air-earth interfaces, Air-water interfaces, Hydrostatic pressure, Aeration zone, Water pressure, Sand, Loam, Soil types, Density, Specific gravity, Permeameters, Hydraulic conductivity, Saturated soils, Retention capacity, Pressure-measuring instruments.

The creation and disruption of water-based blockages in pore space passages play a significant role in determining the air-trapping functions. To improve understanding of hysteretic air permeability relations, a need exists for data on the water content dependence of air permeability, matrix pressure, and air trapping (especially for wetting-drying cycles). To obtain these data, a special instrument was designed which is a combination of a gas permeameter, a suction plate apparatus, and air pycnometer, allowing for air permeability, matrix pressure, and air trapping to be codetermined two nonswelling soils. The extended Darcy equation accurately described the measured flux gradient relations for each condition of absolute gas pressure tested. Air permeability functions exhibited zero-permeability regions at high water contents as well as an abruptly appearing hysteresis at low water contents. Measurements in the zero-permeability regions revealed that the total amount of air in general exceeded the amount of trapped air, indicating that the medium's air space is partitioned into three measurable domains: through-flowing air, locally accessible air, and trapped air. During repeated wetting and drying, the disappearance and reappearance of air permeability coincided closely with the reappearance and disappearance, respectively, of trapped air. The observed relation between critical features of the air permeability functions and those of the air-trapping functions suggest that water-based blockages play a significant role in the disruption of gas-phase connectivity and in preventing air flow, and must be considered in any model of air permeability relations. (Author's abstract)
W90-02585

SMALL PERTURBATIONS SOLUTION FOR STEADY BUT NONUNIFORM INFILTRATION.
Technion - Israel Inst. of Tech., Haifa. Faculty of Agricultural Engineering.
R. Wallach, D. Zaslavsky, and M. Israeli.
Water Resources Research WRERAQ, Vol. 25, No. 9, p 1989-1997, September 1989. 7 fig, 14 ref.

Descriptors: *Soil water, *Infiltration, *Soil absorption capacity, *Dimensional analysis, *Parametric hydrology, *Permeability, Vertical flow, Flow pattern, Boundary conditions, Geohydrologic boundaries, Mathematical studies, Numerical analysis.

When water infiltration into the soil where the infiltration or head distribution over the soil surface is not uniform, it is necessary to consider a two-dimensional or three-dimensional problem with lateral flow as well as vertical flow. The small perturbations method is applied to a two-dimensional flow problem due to a steady but nonuniform infiltration into the soil and a given head at the lower boundary. The perturbation solution is

compared to an analytic solution for periodic distributions of the infiltration. Good accuracy is obtained by only two terms of the expansion. The first term is simply the vertical flow with no lateral terms. In the second term the horizontal flow divergence depends parametrically only on the horizontal distribution and the zero-order approximation, i.e., the vertical flow. For deep lower boundaries the naive perturbation expansion leads to some secular terms that made the convergence poorer. The uniform asymptotic expansion is then used and shown to give an improved accuracy in one term only. The perturbation method is extended to nonperiodic distribution, in fact, any distribution. It may be used for two-dimensional and three-dimensional problems that evade any analytic solutions. One has to solve numerically or analytically only one-dimensional and ordinary linear equations for any number of approximations. The problem is singular in that it accepts at this stage only impermeable vertical boundaries or symmetrical lines. However, this covers a very important class of practical problems. (Author's abstract)
W90-02587

PARAMETRIC MODEL FOR STEEPLY SLOPING FORESTED WATERSHEDS.
Kentucky Univ., Lexington. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W90-02592

WATER INFILTRATION AS AFFECTED BY SOIL CRUST AND MOISTURE PROFILE.
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
J. Morin, R. Keren, Y. Benjamini, M. Ben-Hur, and I. Shainberg.
Soil Science SOSCAK, Vol. 148, No. 1, p 53-59, July 1989. 5 fig, 1 tab, 12 ref.

Descriptors: *Soil water, *Infiltration, *Soil crusts, *Infiltration rate, *Soil water, *Mulching, Wetting, Simulated rainfall, Soil types.

The effect of wetting-front depth on the infiltration rate (IR) of Calcic Haploxeralf and Typic Chromoxerert soils was studied under field conditions using a rainfall simulator. In both soils the infiltration rate decreased more sharply when the wetting front was deeper, but this difference became smaller as the rainstorm continued. When the dry soil surface was covered with mulch, however, the steady-state value of the IR was the same and higher for both soils. The high permeability of the soil during the rainstorm in the presence of mulch and the low steady-state IR values for various prewetting pretreatments both suggested that the moisture regimes in the profile had a negligible effect on the IR in the presence of soil crust. (Author's abstract)
W90-02739

INTERFLOW IN A TILLED, CRACKING CLAY SOIL UNDER SIMULATED RAIN.
Queensland Dept. of Primary Industries, Toowoomba (Australia). Wheat Research Inst.
For primary bibliographic entry see Field 4D.
W90-02776

INFILTRATION MEASUREMENTS WITH DOUBLE-RING INFILTROMETERS AND A RAINFALL SIMULATOR UNDER DIFFERENT SURFACE CONDITIONS ON AN OXISOL.
Soil Management and Conservation Department, Agricultural Research Institute of Parana, Brazil.
N. Sidiras, and C. H. Roth.
Soil and Tillage Research SOTRD5, Vol. 9, No. 2, p 161-168, Feb 1987. 4 tab, 21 ref.

Descriptors: *Brazil, *Infiltration, *Rainfall infiltration, *Cultivated lands, Simulated rainfall, Mulches, Infiltrometers, Tillage systems.

Measurements of the infiltration rate were carried out with double-ring infiltrometers and a rainfall simulator in a field experiment with different

mulch covers and tillage systems on an Oxisol in Parana, Brazil. Both methods of infiltration measurement showed the infiltration rate under black oats (Avena strigosa Schieb.) to be the highest of the mulches tested, and to correlate significantly with mulch rate. Infiltration rates measured with double-ring infiltrometers were highest under conventional tillage and lowest under no-tillage, whereas the rainfall simulator produced inverse results. Final infiltration rates (after 2 h) obtained with the infiltrometers were 5.4, 3.2, and 2.2 times higher than those obtained with the rainfall simulator, for conventional, chisel plough and no-tillage systems, respectively. (Author's abstract)
W90-02777

MEASUREMENTS OF HYDRAULIC CONDUCTIVITY OF SILT LOAM SOILS USING AN INFILTRATION METHOD.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Geography.
For primary bibliographic entry see Field 7B.
W90-02796

PREFERENTIAL SOLUTE TRANSPORT IN LAYERED HOMOGENEOUS SANDS AS A CONSEQUENCE OF WETTING FRONT INSTABILITY.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
R. J. Glass, G. H. Oosting, and T. S. Steenhuis.
Journal of Hydrology JHYDA7, Vol. 110, No. 1/2, p 87-105, Sep 1989. 15 fig, 3 tab, 18 ref.

Descriptors: *Infiltration, *Unsaturated flow, *Path of pollutants, *Soil water, *Solute transport, Sand, Model studies, Ponding, Porosity, Stability.

Laboratory solute transport experiments were carried out in layered homogeneous sand with a fine textured layer overlying a coarse layer. Pulses of blue dye were used to characterize the solute movement. Unlike the traditionally expected one-dimensional homogeneous flow, the solute moves in preferred paths or 'fingers' induced by infiltration flow instability starting at the textural interface between the fine and the coarse layer. The effect of repeated long term ponded infiltration cycles, intermittent ponding events and of uniform initial moisture content at field capacity on the flow field structure and solute breakthrough curves was studied, and the possibility of using a simple lumped dispersion coefficient that includes additional mixing processes due to instability explored. It was determined that wetting front instability has great influence on solute transport through fine over coarse sand systems. The formation of fingers due to the instability within the homogeneous bottom layer in a first infiltration cycle causes a rapid breakthrough of solute and a decrease in the volume of porous medium available for chemical interaction. Intermittent infiltration most closely approximating the natural field condition increases the apparent dispersion by a factor of seven and causes an extremely long tail on the breakthrough curve. (Author's abstract)
W90-02800

WATER FLOW IN A HUMMOCKY LANDSCAPE IN CENTRAL SASKATCHEWAN, CANADA, III. UNSATURATED FLOW IN RELATION TO TOPOGRAPHY AND LAND USE.
Saskatchewan Univ., Saskatoon. Saskatchewan Inst. of Pedology.
For primary bibliographic entry see Field 2F.
W90-02806

HYDROGEOLOGY OF THE SOUTHWESTERN PART OF THE TOWN OF HEMPSTEAD, NASSAU COUNTY, NEW YORK.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-02863

FINITE-ELEMENT ANALYSIS OF THE TRANSPORT OF WATER, HEAT AND SO-

LUTES IN FROZEN SATURATED-UNSATURATED SOILS WITH SELF-IMPOSED BOUNDARY CONDITIONS.
Quebec Univ., Sainte-Foy.
For primary bibliographic entry see Field 2C.
W90-02997

DECOUPLED APPROACH TO THE SIMULATION OF FLOW AND TRANSPORT OF NON-AQUEOUS ORGANIC PHASE CONTAMINANTS THROUGH POROUS MEDIA.
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-03001

TRANSITION POTENTIALS DEFINING THE FLOW BOUNDARIES IN MULTIPHASE POROUS MEDIA FLOW.
SIMULTEC A.G., Zurich (Switzerland).
For primary bibliographic entry see Field 2F.
W90-03002

ENHANCED PERCOLATION MODEL FOR THE CAPILLARY PRESSURE-SATURATION RELATION.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
W. E. Soll, L. A. Ferrand, and M. A. Celia.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 165-170, 2 fig, 5 ref. U.S. Geological Survey

Descriptors: *Porous media, *Immiscibility, *Model studies, *Path of pollutants, *Percolation, *Computer programs, Soil water, Hysteresis, Capillary water, Young-Laplace equation, Mathematical equations, Imbibition, Drainage, Algorithms, Performance evaluation.

Analysis of immiscible flow in porous media requires constitutive relationships between fluid content(s), fluid pressure(s), and relative permeabilities. Laboratory measurement can be expensive and time-consuming. An enhanced percolation model was developed that offers a theoretical framework in which these relationships can be predicted based on measurement of simple fluid and matrix properties. An application of this technique to the hysteretic relationship between capillary pressure and saturation for a two-fluid system is presented. The computation algorithms used are based on the fundamental pore-scale physics of fluid-fluid-solid interactions in porous media. In the pore-scale network, it is assumed that only one fluid resides at a given location at a given time. Once the geometry of the network is fixed, the redistribution of fluids in response to pressure changes is calculated using the Young-Laplace equation. The relationship is shown between capillary pressure and wetting fluid saturation for primary drainage, secondary imbibition, and secondary drainage for a 60 x 60 node network. The curves developed capture the essential behavior of equivalent relationships observed in laboratory samples of porous media. Unlike previously reported techniques, the enhanced percolation model simulates both drainage-imbibition hysteresis and residual wetting and nonwetting fluid saturations. Efficient search and tracking algorithms allow relatively complete inclusion or pore-scale physics while minimizing computation effort. (See also W90-02980) (Rochester-PTT)
W90-03003

HIGH-RESOLUTION FINITE DIFFERENCE SIMULATOR FOR 3D UNSATURATED FLOW IN HETEROGENEOUS MEDIA.
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
R. Ababou, and L. W. Gelhar.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows:

Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 173-178, 2 fig, 3 ref.

Descriptors: *Unsaturated flow, *Infiltration, *Model studies, *Soil water, *Finite difference methods, *Computer programs, Infiltration, Stochastic models, Nonlinear programming, Simulation, Mathematical models, Mathematical equations, Hydraulic conductivity, Supercomputers, Performance evaluation, Heterogeneity.

The nonlinear equation of three-dimensional unsaturated flow is solved here by a finite-difference method for large single realizations of random field coefficients, based on a stochastic approach of field heterogeneity. the most difficult case considered for solution is a transient strip-source infiltration in a large domain discretized into 300,000 grid points, with a spatially random unsaturated conductivity curve. The flow of water in naturally heterogeneous, unsaturated porous formations is not easily accessible to detailed observation in the laboratory. On the other hand, the highly nonlinear equation of unsaturated flow cannot be solved exactly for the non-trivial type of spatial heterogeneity encountered in the field. Although a numerical approach might be feasible, some additional assumption is required to compensate for the lack of detailed input data. To reduce the complexity of the problem, the present approach adopts the view that a stochastic representation of three-dimensional spatial variability will be adequate for investigating the global behavior of large-scale unsaturated flow systems. The strategy to solve the large sparse nonlinear system is as follows: at each time step, the system is linearized iteratively using a modified Picard scheme, and the resulting matrix system is solved by the 'strongly implicit procedure,' a fast sparse iterative matrix solver based on LU factorization. One simulation (300,000 nodes) conducted with this system on a statistically anisotropic soil, with correlation lengths 1 m horizontally and 0.2 m vertically, and a three-dimensional domain size of 15 m horizontally and 5 m vertically, an introduced moisture plume was shown to spread laterally, as previously predicted. Simulation of 10 days of infiltration in this system followed by 10 subsequent days of drainage consumed 5 CPU hours of Cray 2 time, and required 48 megabytes of central memory. (See also W90-02980) (Rochester-PTT)
W90-03004

SUPERCOMPUTER SIMULATIONS OF HETEROGENEOUS HILLSLOPES.
Lancaster Univ. (England). Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2E.
W90-03006

APPLICATIONS OF REMOTE SENSING IN HYDROLOGY.
Agricultural Research Service, Beltsville, MD. Hydrology Lab.
For primary bibliographic entry see Field 2A.
W90-03035

MASS EXCHANGE BETWEEN MOBILE FRESH WATER AND IMMOBILE SALINE WATER IN THE UNSATURATED ZONE.
Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.
H. Gvirtzman, and M. Magaritz.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 235-240, 2 fig, 7 ref.

Descriptors: *Convection, *Dispersion, *Mathematical studies, *Model studies, *Israel, *Solute transport, *Unsaturated flow, *Groundwater movement, *Saline-freshwater interfaces, Percolation, Irrigation, Connate water, Negev Desert, Semiarid lands, Tritium, Isotope studies.

Group 2G—Water In Soils

A profile of tritium concentration measured in the unsaturated zone in loessial sediments in a semiarid area (the northern Negev of Israel) is interpreted in terms of mobile and immobile water domains according to a physical nonequilibrium transport model. The mobile domain is represented by percolating fresh water from both rain and irrigation, and the immobile one is represented by isolated fossil saline water pockets. The two domains are connected by partially-saturated narrow passages within dispersed clay minerals. The transport of mobile water is described by convective-dispersive flow and mass exchange between the two water domains takes place simultaneously. The relevant equations with the given initial-boundary conditions are solved numerically, and the simulated profile is adjusted to fit the measured profile. By taking into account variations of the mass exchange coefficient in relation to matrix characteristics, it was possible to obtain an adequate reconstruction of the measured profile. Temporal changes in matrix characteristics are attributed to dispersion kinetics of clays at the interface between fresh and saline waters. (See also W90-03036) (Author's abstract)
W90-03069

SOLUTION OF SATURATED-UNSATURATED FLOW BY FINITE ELEMENT OR FINITE DIFFERENCE METHODS COMBINED WITH CHARACTERISTIC TECHNIQUE.
Fuzhou Geological Coll. (China).
For primary bibliographic entry see Field 2F.
W90-03070

FINITE ELEMENT SIMULATION OF NITROGEN TRANSFORMATION AND TRANSPORT DURING HYSTERETIC FLOW WITH AIR ENTRAPMENT.
Virginia Polytechnic Inst. and State Univ., Blacksburg.
For primary bibliographic entry see Field 5B.
W90-03071

CHARACTERISTIC FINITE ELEMENT MODEL FOR SOLUTE TRANSPORT IN SATURATED-UNSATURATED SOIL.
Wuhan Inst. of Hydraulic and Electric Power Engineering (China). Dept. of Irrigation and Drainage.
For primary bibliographic entry see Field 5B.
W90-03072

SOLUTE TRANSPORT: EQUILIBRIUM VS NON-EQUILIBRIUM MODELS.
Pontificia Univ. Catolica de Chile, Santiago. Faculty of Engineering.
R. Abeliuk.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 263-268, 2 fig, 9 ref.

Descriptors: *Mathematical studies, *Solute transport, *Path of pollutants, *Solute transport, *Numerical analysis, *Soil water, Infiltration, Hydrodynamics, Equilibrium, Comparison studies, Dispersion, Adsorption, Mathematical models, Chemical reactions.

Numerical experiments were carried out to test whether equilibrium solute-transport data could be described by a non-equilibrium model and vice versa. The Rosenbrock parameter estimation technique was used to find the equilibrium and non-equilibrium model parameters that best fitted the numerically generated non-equilibrium and equilibrium data, respectively. The parameters governing both the equilibrium and non-equilibrium models are those related to the coefficient of hydrodynamic dispersion and those governing the kinetics of the adsorption process for the non-equilibrium model or the distribution coefficient for the equilibrium model. In parameter identification, two situations arise: (1) the coefficient of hydrodynamic dispersion is known or (2) the coefficient of hydrodynamic dispersion is unknown. Two cases are considered: (1) it is assumed that the interaction between the solute and the soil is governed by an equilibrium relationship or (2) it is assumed that interaction between the solute and the soil does not reach equilibrium during the duration of the infiltration event. The results of the application of the parameter search technique to the estimation of the values of the parameters governing the flow of a reactive solute show that information about the physico-chemical aspects of the adsorption process is needed in general to enable discrimination between an equilibrium and a non-equilibrium model. This information can be obtained from simple laboratory experiments. Once the information is obtained, it is possible to estimate the kinetics or equilibrium parameters quite readily by Rosenbrock's parameter search technique. The data required are the concentration and moisture profiles for the adsorbed solute, for the simultaneous determination of the dispersive and the kinetics or equilibrium parameters, or moisture and concentration profiles for a tracer and for a sorbed solute for a separate determination of these parameters. (See also W90-03036) (Rochester-PTT)
W90-03073

MOISTURE-RETENTION PARAMETERS FOR COARSE-TEXTURED SOILS IN SOUTHERN ALBERTA.
Department of Agriculture, Lethbridge (Alberta). Land Evaluation and Reclamation Branch.
D. R. Bennett, and T. Entz.
Canadian Journal of Soil Science CJSSAR, Vol. 69, No. 2, p 263-272, May 1989. 1 fig, 5 tab, 42 ref.

Descriptors: *Soil texture, *Alberta, *Soil water, *Soil moisture retention, Mathematical equations, Field capacity, Wilting point.

A combination of field and laboratory procedures was used to estimate moisture-retention parameters of four coarse-textured soil series in southern Alberta. In situ field capacity moisture content was substantially higher than estimates based on conventional laboratory methods, resulting in significant underestimation of total available moisture. Moisture-retention capacity of all four soil series was found to be adequate for irrigation development. Empirical equations were developed to estimate the upper and lower limits of moisture retention on the basis of particle-size distribution, as determined by the Bouyoucos hydrometer method. Five alternative empirical methods were also evaluated for use in predicting moisture-retention parameters of coarse-textured soils. Equations presented by Rawls et al. (1982) were found to have the best relationship with southern Alberta data for both field capacity and wilting point. (Author's abstract)
W90-03288

FORMS AND HYDROLYTIC BEHAVIOR OF SULPHUR IN HUMIC ACID AND RESIDUE FRACTIONS OF FOUR PEATS FROM THE FRASER LOWLAND.
British Columbia Univ., Vancouver. Dept. of Soil Science.
L. E. Lowe, and R. M. Bustin.
Canadian Journal of Soil Science CJSSAR, Vol. 69, No. 2, p 287-293, May 1989. 5 tab, 13 ref.

Descriptors: *Hydrolysis, *Humic acids, *Deltas, *Soil chemistry, *Wetlands, *Peat, *Sulfur, Nitrogen, Canada, Fraser River, Brackish water, Carbon.

Humic acid and alkali-insoluble residue fractions were isolated from four types of peat from the Fraser River Delta area. The peat fractions were characterized with respect to sulfur forms and response to acid hydrolysis. Total S content of humic acid fractions ranged from 0.3 to 5.5% on an ash-free basis, with 69-83% in C-bonded S form. Nitrogen:sulfur ratios varied between 0.64 and 5.9. The highest S contents and lowest N:S ratios were associated with peats formed under the influence of brackish water. Similar patterns were observed for the alkali-insoluble residue fractions. Only small proportions of S (7.9-17.3%) were recovered in soluble form from the peat fractions after acid hydrolysis, and hydrolysis was accompanied by S losses attributed to volatilization. On average, 4% of the initial C-bonded S was recoverable in that form in the hydrolyzates, whereas 46% of the initial organic sulfate appeared in the hydrolyzate in sulfate form. The low recovery of S in hydrolyzates indicated a correspondingly small contribution of S-amino acids to the C-bonded S fraction. The large proportions of sulfur and carbon resistant to hydrolysis indicated a rather high degree of chemical (and perhaps biological) stability. (Author's abstract)
W90-03289

EFFECTS OF CROPPING ON CARBOHYDRATE CONTENT AND WATER-STABLE AGGREGATION OF A CLAY SOIL.
Agriculture Canada, Sainte-Foy (Quebec). Research Station.
D. A. Angers, and G. R. Mehuys.
Canadian Journal of Soil Science CJSSAR, Vol. 69, No. 2, p 373-380, May 1989. 2 fig, 3 tab, 27 ref.

Descriptors: *Crop production, *Soil-water-plant relationships, *Soil aggregates, *Clays, *Soil chemistry, *Carbohydrates, Carbon, Nitrogen, Alfalfa, Barley, Corn, Fallowing, Soil organic matter.

In a previous study, the mean weight diameter of water-stable aggregates of a clay soil was increased by up to 50% after two growing seasons under barley and alfalfa compared to fallow or corn. The objective of the present study was to determine whether rapid changes in water-stable aggregation under different crops were related to changes in soil carbohydrate content. Compared to fallow or corn, cropping to barley and alfalfa for 2 years did not affect the soil C and N contents but significantly increased carbohydrate content by up to 25%. The correlation between aggregate mean weight diameter and carbohydrate content suggested that at least part of the change in water-stable aggregation was related to carbohydrates. Treatment of the soil with sodium periodate prior to wet-sieving confirmed the partial involvement of carbohydrates in the stabilization of aggregates by crops. The remainder of the crop effect on aggregation was removed by sodium tetraborate which suggests that more-humified, though ill-defined, organic substances were also involved. (Author's abstract)
W90-03290

DIFFUSION OF AMMONIUM AND NITRATE IONS IN FLOODED SOIL AND NITROGEN USE EFFICIENCY OF AN IRRIGATED RICE SYSTEM.
Ministry of Food, Agriculture and Co-operatives, Islamabad (Pakistan).
H. Hanif.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 18, No. 10, p 1155-1172, Oct 1987. 1 tab, 16 ref.

Descriptors: *Diffusion, *Flood irrigation, *Nitrogen, *Soil chemistry, *Soil-water-plant relationships, *Rice, *Soil properties, *Ammonium, *Nitrates, Irrigation effects, Soil water, Fertilizers, Simulation.

A laboratory study was used to simulate the pattern of diffusion of ammonium and nitrate ions in flooded soil. Ammonium, deep incorporated in a submerged irrigation system, diffused upward from the anaerobic to the aerobic layer where biochemical oxidation nitrified it to NO_2 and NO_3. These oxidized N species diffused downward from the aerobic layer to the anaerobic layer where most or at least part, was lost as gaseous end products. Three crops of rice were grown in a glasshouse experiment to estimate N use efficiency under various combinations of irrigation and N management practices. Overall N use efficiency averaged 45%. Under continuous flooding, almost two-thirds of the applied fertilizer N (64% use efficiency) was recovered by the rice crop. Under alternate flooding and drying, the response was very poor, with only about one-fourth (26% use efficiency) of the applied fertilizer N being recovered by the crop. This demonstrated importance of the proper combination of irrigation and fertilizer management in paddy soils to maximize N utilization. (Author's abstract)

W90-03293

RELATIONSHIP BETWEEN WATER SOLU-BLE AND EXCHANGEABLE SOIL CATIONS FOR ESTIMATING PLANT UPTAKE AND LEACHING POTENTIAL.
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
A. N. Sharpley, and E. J. Kamprath.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 19, No. 6, p 739-753, May 1988. 5 fig, 2 tab, 13 ref.

Descriptors: *Cation exchange, *Leaching, *Land disposal, *Soil horizons, *Cations, *Soil chemistry, *Soil-water-plant relationships, Soil analysis, Calcium, Magnesium, Sodium, Potassium, Soil types.

The relationship between water soluble and exchangeable cations (Ca, Mg, Na, and K) was investigated for surface horizons of 195 soils including many taxonomic categories and a wide range in physical and chemical properties from around the world. This will provide information on exchangeable soil cation solubility for use in estimating plant uptake and leaching potential. Amounts of water soluble and exchangeable cations were not consistently related (correlation of 0.50 for Ca, 0.08 for Mg, 0.77 for Na, and 0.49 for K). High correlations were biased by high water soluble and exchangeable cation levels of a few soils that had 3.8-fold and 2.5-fold greater mean than median values. The ratio of exchangeable to water soluble cations was closely related to cation saturation (correlation of 0.87 for Ca, 0.95 for Mg, 0.95 for Na, and 0.93 for K). As the degree of saturation of the exchange complex by a certain cation increased, solubility increased. A change in saturation had less effect on K than on Na, Mg, and Ca solubility. Only exchangeable soil cations (NH4OAc extractable) are routinely measured and reported in soil survey reports, thus water soluble levels may be determined from cation saturation. This will allow estimation of the amounts of cation that can potentially move in solution through the soil or be taken up by plants. Use of cation saturation, in addition to exchangeable content, will better characterize soil cation availability by representing quantity, intensity, and buffer factors. (Author's abstract)
W90-03297

EFFECT OF TWO SOIL MOISTURE LEVELS AND WETTING-DRYING CYCLES ON MANGANESE RELEASE IN NACL-AMENDED SOILS.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
R. A. Khattak, and W. M. Jarrell.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 20, No. 1-2, p 23-45, Jan 1989. 4 fig, 5 tab, 41 ref.

Descriptors: *Soil-water-plant relationships, *Wetting, *Drying, *Saline soils, *Soil amendments, *Soil water, *Manganese, *Sodium chloride, *Soil chemistry, Soil analysis, Cations, Calcium, Sodium, Potassium.

Effect of two moisture levels (22.5 and 13.5%, w/w) and wetting-drying cycles on manganese solubility was studied in NaCl-amended soil. During 6 days incubation, higher moisture level released 40-fold more water-soluble Mn and 60-fold more NH4OAc-exchangeable-Mn in non-salinized soil. In NaCl-treated soil, 50 to over 200% greater soluble and exchangeable Mn was recovered from samples incubated at 22.5%, compared to 13.5% water levels. Wetting-drying cycles significantly decreased water-soluble Mn, which accounted for 50 to 60% increases in the exchangeable Mn. Since other non-oxidizing/reducing cations (Ca, Mg, Na, K) also demonstrated similar behavior, it is proposed that in addition to oxidation upon drying and reduction upon wetting, the increases in exchangeable Mn and simultaneous decreases in soluble Mn concentration are due to sorption processes. These results suggest that under field conditions, the insolubility of Mn due to continued wetting-drying cycles may eventually lead to Mn deficiency in soils low in Mn. (Author's abstract)
W90-03302

WATER RELATIONS OF GRAPEFRUIT TREES IN RESPONSE TO DRIP, MICROSPRINKLER, AND OVERHEAD SPRINKLER IRRIGATION.
Citrus Research and Education Center, Lake Alfred, FL.
For primary bibliographic entry see Field 3F.
W90-03319

ORCHARD SOIL MANAGEMENT SYSTEMS INFLUENCE RAINFALL INFILTRATION.
Appalachian Fruit Research Station, Kearneysville, WV.
For primary bibliographic entry see Field 3F.
W90-03360

COMPARISON OF THE AVAILABLE-WATER CAPACITIES OF PATUMAHOE CLAY LOAM UNDER PASTURE AND CULTIVATION.
New Zealand Soil Bureau, Lower Hutt.
M. W. Gradwell.
New Zealand Journal of Agricultural Research NEZFA7, Vol. 30, No. 3, p 367-372, 1987. 6 tab, 16 ref.

Descriptors: *Soil-water-plant relationships, *Moisture tension, *Soil water potential, *Clays, *Loam, *Pastures, Soil water, Horticulture, Topsoil, Organic carbon, Cultivated lands.

The amount of water that topsoils of the Patumahoe clay loam can retain at tensions between 0.2 and 15.0 bars (available-water capacity) has been determined for four sites under pasture and eleven sites in market gardens. The mean available-water capacity of the 2-12 cm depth was 18% of soil volume under pasture and 11% in gardens; for the 12-22 cm depth the mean available-water capacity was 10% under pasture and 12% in gardens. The difference between pasture and gardens was highly significant for the upper topsoil but not significant for the lower topsoil; the available-water capacity varied significantly with depth under pasture but not gardens. The large available-water capacities near the surface under pasture derived from exceptionally high values of field capacity which may have been related to high contents of organic carbon in the soil. Any advantage of the pasture over the cultivated sites in the water-supplying power of the topsoil as a whole was of doubtful significance. (Author's abstract)
W90-03374

LAND PREPARATION REQUIREMENTS FOR RAINFED RICE AS AFFECTED BY CLIMATIC WATER BALANCE AND TILLAGE PROPERTIES OF LOWLAND SOILS.
International Rice Research Inst., Los Banos, Laguna (Philippines).
For primary bibliographic entry see Field 3F.
W90-03380

WATER MOVEMENT AND MACROPOROSITY OF AN AUSTRALIAN ALFISOL UNDER DIFFERENT TILLAGE AND PASTURE CONDITIONS.
New South Wales Dept. of Agriculture, Rydalmere (Australia). Biological and Chemical Research Inst.
K. Y. Chan, and J. A. Mead.
Soil and Tillage Research SOTRD5, Vol. 14, No. 4, p 301-310, Sep 1989. 5 fig, 1 tab, 12 ref.

Descriptors: *Agricultural runoff, *Cultivation, *Rainfall infiltration, *Pastures, *Soil porosity, Conventional tillage, Australia, Tillage, Rainfall simulators, Soil solution, Leaching, Tracers, Porosity.

We assessed the effect of different tillage practices (i.e. conventional tillage and direct drilling) and pasture conditions on the infiltration and distribution of infiltrated rain water in an Australian Alfiso was studied. Bromide was used as a tracer for the infiltrated rain under simulated rainfall conditions. The different infiltration patterns were then related to the macroporosity of the soils. A 25-year-old permanent pasture had the highest density (number per acre) of macropores and percentages of transmitting macropores. A 9-year-old pasture phase in a pasture/crop rotation did not fully restore the macroporosity of the soil. Conventional cultivation by scarifying to 0.1 m for 4 years significantly reduced macropore density as well as continuity when compared with the pasture soil. The reduced macroporosity led to increased run-off by reducing preferential flow and altered the pathway of infiltrated water movement. As a consequence, the increase in water content below 0.1 m in the cultivated soil was predominantly from downward displacement of original soil solution, resulting in more leaching. The infiltrated rain water largely remained on the surface 0.1-m layer. In contrast, macroporosity found under direct drilling was similar to that of the pasture soil. (Author's abstract)
W90-03382

DEPLETION AND MOVEMENT OF WATER BENEATH CEREAL CROPS GROWN ON A SHALLOW SOIL OVERLYING CHALK.
Reading Univ. (England). Dept. of Soil Science.
P. J. Gregory.
Journal of Soil Science JSSCAH, Vol. 40, No. 3, p 513-523, September 1989. 5 fig, 5 tab, 18 ref.

Descriptors: *Cereal crops, *Soil water, *Soil water potential, *Chalk, *Soil-water-plant relationships, *Plant growth, Water potentials, Water use, Root zone.

Changes in water storage and gradients of water potential were measured beneath cereal crops grown on Andover soil series for three seasons. The measurements showed that depletion of water from the soil (0-0.3 m) was 20-29% of the total profile depletion and that from the chalk/soil and chalk layers was 71-80%. Rain showers rewet the soil so that depletion from the non-soil layers contributed about 35% of the total water use despite containing only 12% of the roots. Water in the chalk/soil and chalk layers was held at matric potentials between -200 and -800 kPa and gradients of hydraulic potential indicated upward movement from depths of almost 3 m. Comparisons of measured water depletion beneath the root zone with estimates of upward movement to the rooting zone indicate that substantial upward movement is possible, although the estimates were generally larger than the measured depletion. The estimated contribution of the water moved to the root zone for shoot dry matter production was 8% and 22% for winter and spring cereals, respectively. (Author's abstract)
W90-03407

SIMPLE PREDICTIVE APPROACH TO SOLUTE TRANSPORT IN LAYERED SOILS.
Oxford Univ. (England). Dept. of Plant Sciences.
For primary bibliographic entry see Field 5B.
W90-03408

USABLE MECHANISTIC MODEL OF NITRATE LEACHING: I. THE MODEL.
Imperial Chemical Industries Ltd., Bracknell (England). Plant Protection Div.
For primary bibliographic entry see Field 5B.
W90-03409

USABLE MECHANISTIC MODEL OF NITRATE LEACHING: II. APPLICATION.
Imperial Chemical Industries Ltd., Bracknell (England). Plant Protection Div.
For primary bibliographic entry see Field 5B.
W90-03410

MEASURING UNSATURATED SORPTIVITY AND HYDRAULIC CONDUCTIVITY USING MULTIPLE DISC PERMEAMETERS.
Commonwealth Scientific and Industrial Research Organization, Adelaide (Australia). Div. of Soils.
K. R. J. Smettem, and B. E. Clothier.
Journal of Soil Science JSSCAH, Vol. 40, No. 3, p 563-568, September 1989. 3 fig, 2 tab, 16 ref.

Descriptors: *Soil physics, *Soil water, *Hydraulic conductivity, *Sorption, *Permeameters, *Loam.

A new field method was developed for obtaining, with minimal disturbance, the unsaturated hydraulic conductivity and sorptivity from unconfined disc permeameter measurements. Conventionally, the sorptivity is obtained from the initial square-root-of-time behavior of discharge from the disc permeameter. In some cases this can be difficult to measure, in part because multi-dimensional flows approach quasi-steady state very rapidly. As an alternative the ponded twin-ring method was extended to unsaturated discs of several radii. This method has the advantage that only long-time, quasi-steady discharges are needed to obtain hydraulic conductivity and sorptivity. The two methods were tested using data obtained for a fine sandy loam at a supply potential of -35 mm, and agreement was good. (Author's abstract)
W90-03411

CATION TYPE AND IONIC STRENGTH EFFECTS ON THE SOLUTION COMPOSITION OF AN ACIDIC SUBSOIL.
Department of Agriculture and Water Supply, Pietermaritzburg (South Africa). Natal Region.
A. D. Manson, and M. V. Fey.
Journal of Soil Science JSSCAH, Vol. 40, No. 3, p 577-583, September 1989. 5 fig, 1 tab, 17 ref.

Descriptors: *Soil solution, *Soil chemistry, *Subsoil, *Aluminum, *Acidic soils, *Cations, *Salts, Sodium, Potassium, Magnesium, Calcium, Silica, Gibbsite, Kaolinite, Hydrogen ion concentration, Fertilizers.

Sodium, potassium, magnesium and calcium chloride solutions of four concentrations (0.4, 1.0, 4.0, 10.0 meq/cu dm) and distilled water were equilibrated with the highly weathered, acidic subsoil of a Plinthic Paleudult from Natal at a soil:solution ratio 2.2:1, then separated by centrifugation with an immiscible liquid and analyzed for inorganic solutes. With each salt, increasing ionic strength resulted in lower solution pH (the maximum pH was 4.95 in the distilled water equilibration) and higher aluminum concentration and activity. These effects were much less marked for sodium (maximum delta pH of 0.47) than for the other cations (maximum delta pH of 0.83) and both the concentration and activity of aluminum were correspondingly lower (by 10-fold at the highest chloride concentration) in the sodium solutions. Irrespective of the nature or concentration of the electrolyte added, pH and the activities of $Al(3+)$ and silica in solution were consistently interrelated in a way which suggests that equilibrium with the gibbsite and poorly crystalline kaolinite in this soil had been closely approached. The results provide a basis for anticipating the effect of infiltrating solutions of fertilizer salts on subsoil acidity and suggest that a beneficial effect may accrue from the presence of sodium in the cation suite of acid soils. (Author's abstract)
W90-03412

EFFECTS OF LIME APPLICATIONS TO PARTS OF AN UPLAND CATCHMENT ON SOIL PROPERTIES AND THE CHEMISTRY OF DRAINAGE WATERS.
University Coll. of Wales, Aberystwyth. Soil Science Unit.
W. A. Adams, and G. M. Evans.
Journal of Soil Science JSSCAH, Vol. 40, No. 3, p 585-597, September 1989. 1 fig, 10 tab, 23 ref.

Descriptors: *Soil chemistry, *Lime, *Catchment areas, *Drainage water, *Soil amendments, *Liming, *Water chemistry, *Cations, *Anions, *Acidic soils, Hydrogen ion concentration, Aluminum, Calcium, Leachates, Wales.

The liming of soils in the lower part of an upland catchment had a major effect on both soil properties and the chemistry of drainage waters. Exchangeable Al was closely correlated with soil pH and showed a very steep rise from 2.6-4.8 meq/L over the pH range 5.5-4.5. As streams flowed from unimproved through improved land there was an increase in pH and the concentration of all major

anions and basic cations. The greatest increase was in Ca (approximately 3.5-fold). The concentrations of all dissolved Al species decreased, with inorganic monomeric Al falling to near zero. Leachates were examined from soils representative of the most acidic and the least acidic. Calcium concentrations differed by almost tenfold. Al was present in leachates from the limed soil, but most was unreactive and none was inorganic monomeric. Most of the Al leached from the acid soil was monomeric. A model of soil acidification is proposed in which soil Ca is depleted at a rate of 8% of the exchangeable Ca/yr. The model predicts that liming a soil to neutrality would be likely to influence drainage water chemistry for 30-40 years and that the most acidic soils of the catchment show no net loss of Ca to drainage. (Author's abstract)
W90-03413

DETERMINATIONS OF UNSATURATED HYDRAULIC CONDUCTIVITY FOR CANDLER SAND.
Florida Univ., Gainesville. Dept. of Soil Science.
R. A. T. Kablan, R. S. Mansell, S. A. Bloom, and L. C. Hammond.
Soil Science SOSCAK, Vol. 148, No. 3, p 155-164, September 1989. 8 fig, 4 tab, 29 ref.

Descriptors: *Soil water, *Soil physics, *Sand, *Hydraulic conductivity, *Mathematical models, Interstitial water.

Using an instantaneous profile (IP) method, in situ distributions of volumetric water content, theta(z,t), and water suction head, h(z,t), were generated in two field profiles of Candler sand during a cycle of soil-water redistribution. With these data, hydraulic conductivity, K, values were calculated over the narrow suction head range $0 < h < 80$ cm of water. Field-determined values for saturated hydraulic conductivity exceeded 100 cm/h for this very course-textured soil. Values of K determined by the IP method were used to evaluate two methods commonly used to predict unsaturated hydraulic conductivity. The two methods utilized field-determined soil-water characteristic curves, theta(h), experimentally determined values of saturated hydraulic conductivity, and Poiseuille's equation for flow in cylindrical soil pores to calculate unsaturated hydraulic conductivity. For values of theta > 0.10 cu cm/cu cm and h < 40 cm of water, K values predicted by each of the methods agreed well with values determined in situ by the IP method. However, for lower water contents (i.e., theta < 0.10 cu cm/cu cm), values of K determined by both predictive methods overestimated those obtained by the IP method. (Author's abstract)
W90-03414

FIRST INTEGRALS OF THE INFILTRATION EQUATION: 2. NONLINEAR CONDUCTIVITY.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
W. L. Hogarth, J.-Y. Parlange, and R. D. Braddock.
Soil Science SOSCAK, Vol. 148, No. 3, p 165-171, September 1989. 2 fig, 3 tab, 10 ref, append. Australian Research Grant Scheme Award F85161771.

Descriptors: *Soil water, *Soil physics, *Infiltration, *Hydraulic conductivity, *Diffusivity, Mathematical equations, Soil properties, Boundary conditions.

The infiltration equation with a time-dependent surface flux was solved numerically for nonlinear conductivities, using first-integral and shooting techniques. The diffusivity and conductivity were both taken as power laws. The relative accuracy of the numerical technique were obtained by comparison with the case of linear conductivity, where an exact analytical solution exists. An approximate analytical result was compared with the solution for nonlinear conductivities from the shooting technique. The approximate analytical result was an excellent approximation to the exact numerical solution. It is suggested that the solution obtained can be used to validate the numerical solution of Richard's equation for arbitrary soil properties and arbitrary boundary conditions. (Author's abstract)

W90-03415

RAPID AND NUMERICALLY STABLE SIMULATION OF ONE-DIMENSIONAL, TRANSIENT WATER FLOW IN UNSATURATED, LAYERED SOILS.
Aalborg Universitetscenter (Denmark). Dept. of Civil Engineering.
P. Moldrup, D. E. Rolston, and J. A. Hansen.
Soil Science SOSCAK, Vol. 148, No. 3, p 219-226, September 1989. 7 fig, 7 ref.

Descriptors: *Soil water, *Soil physics, *Soil water potential, *Hydraulic conductivity, *Model studies, Computer models, Simulation, Unsaturated flow, Soil properties.

A rapid numerical solution for vertical, transient flow of water in unsaturated soil was developed. The model is labeled the moving mean slope model (MMS model), because it uses the slope of the natural log of the hydraulic conductivity versus soil-water potential curve as a dynamic parameter. The MMS model was developed from a model for flow in homogeneous, relatively wet soils presented by Wind and van Doorne. The model can simulate transient flow in homogeneous and heterogeneous soils correctly for any range of soil-water content. This has been validated against semianalytical solutions and solutions obtained with traditional finite-difference and finite-element models. A Courant number analysis method can be used to make direct comparisons of criteria for avoiding numerical errors for the MMS model compared with traditional finite-difference models. For coarse-textured soils, the MMS model uses about the same computer time as the traditional finite-difference and finite-element models. For soil ranging from fine-textured to medium-textured, the MMS model is one to several orders of magnitude faster than the traditional numerical models. (Author's abstract)
W90-03416

DOWNSLOPE MOVEMENT OF CHLORSULFURON AFTER CONVENTIONAL AND OVER-SNOW APPLICATIONS TO WINTER WHEAT.
Utah State Univ., Logan. Dept. of Plant Science.
For primary bibliographic entry see Field 5B.
W90-03417

IMPROVED FIELD PROBES FOR SOIL WATER CONTENT AND ELECTRICAL CONDUCTIVITY MEASUREMENT USING TIME DOMAIN REFLECTOMETRY.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
For primary bibliographic entry see Field 7B.
W90-03423

METABOLISMS OF 14C-CARBARYL AND 14C-1-NAPHTHOL IN MOIST AND FLOODED SOILS.
Bhabha Atomic Research Centre, Bombay (India). Nuclear Agriculture Div.
For primary bibliographic entry see Field 5B.
W90-03444

MODELLING WATER-TABLE MOVEMENT IN FLAT LOW-LYING LANDS.
Silsoe Coll. (England).
For primary bibliographic entry see Field 2F.
W90-03499

INFILTRATION AT THE TAI RAIN FOREST (IVORY COAST): MEASUREMENTS AND MODELLING.
Groningen Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
A. Wierda, A. W. L. Veen, and R. W. A. Hutjes.
Hydrological Processes HYPRE3, Vol. 3, No. 4, p. 371-382, October-December 1989. 6 fig, 1, tab, 35 ref.

Descriptors: *Rainfall infiltration, *Rain forests, *Tropical regions, *Model studies, *Ivory Coast, *Forest hydrology, *Infiltration rate, Soil water, Storage capacity, Soil porosity, Mein-Larson model, Rainfall intensity, Overland flow, Infiltrometers.

Infiltration experiments have been performed at three sites along a well-known catena under virgin tropical rain forest using a portable sprinkling infiltrometer. Experimentally determined infiltration curves are presented. Infiltration curves were also simulated on the basis of the Mein-Larson equation. The parameters for this model have been obtained from the infiltration curves (saturated conductivity) and simple soil moisture determinations (fillable porosity). The agreement between experimentally determined and modelled infiltration was reasonable, provided (a) saturated conductivity as derived from the experimental data is corrected, (b) a storage parameter, also derived from the experimental data, is added to the Mein-Larson model, and (c) the decline in soil porosity with depth is either small or occurs abruptly at shallow depth. Comparison of observed infiltration rates with rainfall intensity shows that Horton Overland Flow has to occur naturally at least on the middle and lower section of the catena. Despite the fact that most parameters can be estimated in principle from basic soil data, it is advisable to obtain sprinkling infiltrometer field measurements, because of soil variability due to dynamic surface conditions, macroporosity, air entrapment, and irregularity of the wetting front. (Author's abstract)
W90-03505

CHANGES IN PHYSICAL PROPERTIES OF YOUNG AND OLD VOLCANIC SURFACE SOILS IN COSTA RICA AFTER CLEARING OF TROPICAL RAIN FOREST.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Geology.
For primary bibliographic entry see Field 4C.
W90-03506

USE OF SEWAGE SLUDGE AS SOIL AMENDMENT: EFFECT ON YIELD OF FORAGE AND SOIL CHEMICAL PROPERTIES.
Puerto Rico Univ., Mayaguez. Dept. of Agronomy and Soils.
For primary bibliographic entry see Field 5E.
W90-03547

2H. Lakes

HISTORICAL RECONSTRUCTIONS AND FUTURE FORECASTS OF REGIONAL SURFACE WATER ACIDIFICATION IN SOUTHERNMOST NORWAY.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W90-02589

TOXIC SIGNIFICANCE OF PLANAR AROMATIC COMPOUNDS IN BALTIC ECOSYSTEM: NEW STUDIES ON EXTREMELY TOXIC COPLANAR PCBS.
Jyvaeskylae Univ. (Finland). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W90-02614

ROLE OF SEDIMENTS IN THE DISTRIBUTION OF UCA PUGILATOR (BOSC) AND UCA PUGNAX (SMITH) (CRUSTACEA, BRACHYURA) IN A SALT MARSH OF CAPE COD.
Universidad Austral de Chile, Valdivia. Inst. de Zoologia.
E. Jaramillo, and K. Lunecke.
Meeresforschung MEERDW, Vol. 32, No. 1, p 46-52, August 1988. 3 fig, 11 ref.

Descriptors: *Sediments, *Crustaceans, *Distribution patterns, *Salt marshes, *Ecology, Mud, Cape Cod, Massachusetts, Organic matter.

The distribution of the fiddler crabs Uca pugilator (Bosc) and Uca pugnax (Smith) in relation to the quality of the sediments was analyzed in the Great Sippesiddett Marsh, Cape Cod, Massachusetts. The study involved a survey of crab distribution along a transect of 150 meters, together with the laboratory and field experiments dealing with substrate burrowing preference. U. pugilator was found along most of the transect with exception of stations with greater than 15% of mud. U. pugnax was restricted to sediments with high percentages of mud, organic matter and plant cover. Laboratory substratum preference experiments showed that U. pugilator dug in sandy and muddy sediments, but mostly in sand. U. pugnax made burrows almost exclusively in muddy sediments. Field substratum preference experiments (reciprocal transplants of sediments) generally agreed with the laboratory results. U. pugilator dug in both kinds of substrate in the sandy area, but only in the sandy squares in the muddy area. U. pugnax made burrows only in the muddy squares, regardless of the area. The quality of the sediments play a more significant role in the distribution of U. pugnax than in U. pugilator. For U. pugilator, factors other than quality of substratum may be involved in its present pattern of distribution. (Author's abstract)
W90-02645

RULE-BASED ECOLOGICAL MODEL FOR THE MANAGEMENT OF AN ESTUARINE LAKE.
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Computational and Applied Mathematics.
For primary bibliographic entry see Field 2L.
W90-02656

VERIFICATION OF THE MATHEMATICAL MODEL OF NITROGEN CIRCULATION WITH AND WITHOUT LIGHT ACCESS.
Slovenska Akademia Vied, Bratislava (Czechoslovakia). Ustav Experimentalenj Biologie a Ekologie.
For primary bibliographic entry see Field 7C.
W90-02657

MEIOBENTHIC NAIDID AND AEOLOSOMATID OLIGOCHAETES FROM THE PROFUNDAL ZONE, AND RELATIONS OF SPECIES TO EUTROPHICATION.
Jyvaeskylae Univ. (Finland). Dept. of Biology.
J. Sarkka.
Hydrobiologia HYDRB8, Vol 180, p 185-190, August 15, 1989. 2 fig, 2 tab, 11 ref.

Descriptors: *Limnology, *Water pollution effects, *Oligochaetes, *Eutrophication, Aquatic animals, Eutrophic lakes, Spatial distribution, Lake Paijanne, Finland, Eutrophic lakes, Spatial distribution.

Oligochaetes were sampled using meiobenthos methods from depths of between 20 and 94 meters in Lake Paijanne, Finland in 1986. Individuals belonging to several species of the Naididae and Aeolosomatidae, which are generally considered to include mainly littoral or lotic species, were found more or less regularly at these profundal depths. The naidid species Chaetogaster langi and Amphichaeta laydigii were more abundant in the deepest areas than at 20 meters. Species also appeared to react differently to water quality. The naidid species Chaetogaster langi and the aeolosomatid species Aeolosoma quaternarium, A. hamprichi and Rheomorpha neiswestnovae were most abundant on average at oligotrophic, unpolluted stations, naidid species Amphicheta leydigii, Specaria josinae and Vejdovskyella comata were more abundant at eutrophic stations and Dero digitata was more abundant in organically loaded areas. The observations of Amphichaeta leydigii, Chaetogaster setosus and Rheomorpha neiswestnovae were new for Finland. (Author's abstract)
W90-02663

INFLUENCE OF TREE CANOPIES ON THE QUANTITY OF WATER AND AMOUNT OF CHEMICAL ELEMENTS REACHING THE PEAT SURFACE OF A BASIN MIRE IN THE MIDLANDS OF ENGLAND.
Nottingham Univ. (England). Dept. of Botany.
A. Ahmad-Shah, and J. O. Rieley.
Journal of Ecology JECOAB, Vol. 77, No. 2, p 357-370, June 1989. 5 fig, 5 tab, 36 ref.

Descriptors: *Wetlands, *Water chemistry, *Nutrients, *Limnology, *Canopy, *Forest watersheds, *Trees, *Pine trees, *Fens, *Throughfall, Rainfall, Sodium, Potassium, Peat soils, Nutrients, Sulfates, Calcium, Magnesium, Ammonium, Sulfur compounds, Chlorides.

The influence of three different tree canopies on the quantity and chemical composition of rainfall was studied at a small forested basin mire for two years. Percentage throughfall of incident precipitation under pine, fen and mixed broadleaved woodlands was 68%, 79%, and 80%, respectively. Marked variation was also observed over time. Substantial quantities of plant nutrient elements reach the mire surface in rainfall which is supplemented in passing through the tree layer. The order of increase in total chemical complement of throughfall is: pine woodland > fen woodland > mixed woodland. Comparison is made with rainfall and throughfall data collected at other forest sites in Britain and elsewhere. The ways in which vegetation canopies may change the chemical content of rainfall are discussed and the external sources of nutrient enrichment to rainfall are considered. Of the ions studied, those which show greatest increase in passing through the tree canopies are sodium, potassium, calcium, magnesium, ammonium, sulphate and chloride. The highest input occurs during the winter months when rainfall is maximal. (Author's abstract)
W90-02668

MACRO- AND MICROALGAL PRODUCTION WITHIN A NITELLA OPACA BED IN LAKE THINGVALLAVATN, ICELAND.
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
T. Kairesalo, G. S. Jonsson, K. Gunnarsson, and P. M. Jonasson.
Journal of Ecology JECOAB, Vol. 77, No. 2, p 332-342, June 1989. 7 tab, 30 ref.

Descriptors: *Algae, *Biomass, *Limnology, *Aquatic plants, *Primary productivity, Lake Thingvallevatn, Iceland, Seasonal distribution.

Nitella opaca forms a dense bed at a depth of 10-18 meters in Lake Thingvallavatn, Iceland. In 1985 Nitella started to grow in early May and achieved maximum height (70-80 cm) and biomass (up to 170 gm dry weight/ sq m, or about 50 gm C/sq m) in October. During November and December the macroalgae collapsed and many of the thalli became detached. During May-September the average Nitella biomass accumulation, calculated from successive harvesting, was 153 +/-10 (S.E.) mg C/sq m/d at a depth of 10-16 meters. This figure was consistent with net production calculated from short-term (0.5-3 hr) measurements of C-14 fixation under both laboratory and field conditions. However, measurements of O2 exchange yielded distinctly higher community production rates than did the C-14 method, possibly due to the recycling of C(14)O2. Field measurements of C-14 fixation in 56 L of 112 L acrylic plastic chambers showed that during July-September, 40-78% of the total primary production of the Nitella community was attributable to epiphytic (+ epipelic) and planktonic microalgae (mainly diatoms). Microalgal production would seem to be sufficient to sustain the rich benthic fauna (especially the larvae of Chironomus islandicus) living among the Nitella thalli. (Author's abstract)
W90-02669

ABOVE-GROUND NUTRIENT TURNOVER AND NET PRIMARY PRODUCTION OF AN EVERGREEN AND A DECIDUOUS SPECIES IN A HEATHLAND ECOSYSTEM.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.
R. Aerts, and F. Berendse.
Journal of Ecology JECOAB, Vol. 77, No. 2, p 343-356, June 1989. 7 fig, 7 tab, 21 ref.

Group 2H—Lakes

Descriptors: *Wetlands, *Nutrients, *Primary productivity, Deciduous trees, Leaves, Litter, Grasses.

Above-ground nutrient turnover and primary production (NPP) in adjacent wet heathland communities dominated by the evergreen dwarfshrub Erica tetralix and the deciduous perennial grass Molinia caerulea were studied for two year in The Netherlands. The evergreen was able to achieve a high NPP in early spring (March-May), which accounted for 28% of total annual NPP. There was no NPP in winter (October-March). Secondary thickness growth accounted for 31-49% of NPP in the evergreen. The growing season of the deciduous species lasted from April until September. The above-ground NPP was 2.1-2.6 times higher than that of the evergreen. Leaf litter production by the evergreen only occurred during the summer. Leaf litter production of Molinia occurred in autumn. Life expectancy of the leaves was three times as high in the evergreen compared with the deciduous species. The evergreen reduced nutrient losses mainly by leaf longevity, a relatively low allocation of nutrients to the leaves and low tissue nutrient concentrations. The deciduous species reduced nutrient losses mainly by a very efficient retranslocation of nutrients from senescing tissues. Retention of nutrients was greater and NPP was smaller in the evergreen shrub than in the grass. It is suggested that there is a trade-off between these two plant characteristics. It is shown that the differences in nutrient turnover and productivity between Erica and Molinia may explain the replacement of Erica by Molinia in wet heathlands when nutrient availability increases. (Author's abstract)
W90-02670

PATCHINESS, COLLAPSE AND SUCCESSION OF A CYANOBACTERIAL BLOOM EVALUATED BY SYNOPTIC SAMPLING AND REMOTE SENSING.
Arizona State Univ., Tempe. Dept. of Zoology.
For primary bibliographic entry see Field 7B.
W90-02673

BACTERIOPLANKTON GROWTH, GRAZING MORTALITY AND QUANTITATIVE RELATIONSHIP TO PRIMARY PRODUCTION IN A HUMIC AND A CLEARWATER LAKE.
Lund Univ. (Sweden). Inst. of Limnology.
L. J. Tranvik.
Journal of Plankton Research JPLRD9, Vol. 11, No. 5, p 985-1000, September 1989. 3 fig, 5 tab, 50 ref.

Descriptors: *Limnology, *Transparency, *Bacteria, *Bacterial analysis, *Growth rates, *Lakes, Substrates, Organic carbon, Primary productivity, Secchi disks, Dissolved solids, Food chains.

Bacterial growth and grazing mortality were estimated from May to October in two south Swedish oligotrophic lakes, one being a clearwater lake (water color 5-10 Pt/L DOC 2.9-3.4 m/L, Secchi disk depth 5.0-9.4 m) and the other a humic, brownwater lake (water color 105-165 mg Pt/L, DOC 13.7-22.7 mg/L, Secchi disk depth 1.3-2.1 m). Specific rates of growth and grazing mortality were generally similar for both lakes. However, the abundance of bacteria was consistently 2-3 times higher in the water of the humic lake, suggesting that the total production and consumption of bacterial cells were also higher than in the clearwater lake. The ratio of bacterial secondary production to primary production was higher in the humic lake than in the clearwater lake, indicating that the bacterioplankton of the humic lake utilize allochthonous substrates, in addition to substrates originating from autochthonous primary production. Most of the bacterial loss in both lakes could be attributed to small protozoan grazers. This implies that allochthonous and autochthonous organic carbon fixed by bacterioplankton is less important in terms of carbon flow to higher trophic levels than would be expected if macrozooplankton were the dominant bacteriovores, providing a more direct and efficient transfer of carbon to larger organisms. (Author's abstract)
W90-02674

PHYSICO-CHEMICAL CONTROL OF THE GROWTH OF A DIATOM, ASTERIONELLA FORMOSA HASS., IN A SHALLOW EUTROPHIC LAKE.
Tokyo Univ. (Japan). Dept. of Botany. .
S. Kudoh, and M. Takahashi.
Journal of Plankton Research JPLRD9, Vol. 11, No. 5, p 1001-1019, September 1989. 9 fig, 2 tab, 28 ref. Japanese Ministry of Education, Science and Culture grant 60129034.

Descriptors: *Growth rates, *Algae, *Diatoms, Seasonal variation, Physicochemical properties, Lake Suiwa, Limiting factors, Limiting nutrients, Population dynamics, Mathematical models.

Physico-chemical environmental control of the growth rate of an algal population, the pennate diatom Asterionella formosa Hass., was investigated for a year in natural water (shallow eutrophic Lake Suiwa, Japan). This species occurred in vegetative form in the water column all the time, although its population density varied by five orders of magnitude from a maximum of 1.4 million cells/L in February to a minimum of 80 cells/L in August. A mathematical model of a combination of multiplicative and Liebig types suggested that vegetative cells were severely limited in their growth rate, reaching almost 80% depression of the maximum rate between December and February by low temperatures and nearly 50% depression in warm seasons by light intensity. Nutrient limitations were only observed in May, August and September, although they were not as great as by temperature and light intensity in the study lake. Population changing rates of A. formosa determined in the lake were low and agreed well with the estimated growth rates during winter, but those in summer were low and disagreed with the estimated high growh rates. This suggests that population change of the species was highly dependent upon the specific growth rate in winter, but other factors became predominant in summer. (Author's abstract)
W90-02675

DIEL PATTERNS OF ZOOPLANKTON GRAZING IN A SHALLOW LAKE.
Ecole Normale Superieure, Paris (France). Lab. d'Ecologie.
S. Mourelatos, C. Rougier, and R. Pourriot.
Journal of Plankton Research JPLRD9, Vol. 11, No. 5, p 1021-1035, September 1989. 6 fig, 2 tab, 57 ref. Financial support from the GRECO 'Fonctionnement des Systemes Lacustres' CNRS and PIREN.

Descriptors: *Limnology, *Feeding rates, *Zooplankton, *Lakes, Physicochemical properties, Creteil Lake, Daphnia, Chlorella.

A diel survey of in situ species-specific zooplankton clearance rates (with radioactively labelled Chlorella cells) was conducted in the shallow lake of Creteil characterized by small-sized planktonic forms (algae less than 10 micrometers and zooplankton less than 1.3 millimeters). Experiments were performed every four hours at two depths (1 and 4 meters). Power functions relating individual filtering rates to body length were established for the three most abundant cladocerans and for calanoids (nauplii being included in this feeding group), for each depth and time. No filtering periodicity was observed in Ceriodaphnia species, adults and copepodites of Eudiaptomus gracilis and Eurytemora velox, and nauplii. On the contrary, clear nocturnal filtering peaks were obtained for Daphnia species and for Diaphanosoma brachyurum, these being more pronounced for the larger individuals at one meter deep. The observed diel periodicity cannot be explained by variations in physico-chemical parameters or food concentration alone. (Author's abstract)
W90-02676

CARBON AND CHLOROPHYLL CONTENT OF PHYTOPLANKTON FROM VARIOUS NUTRIENT REGIMES.
Vandkvalitetsinstitutet, Hoersholm (Denmark).
For primary bibliographic entry see Field 7B.
W90-02677

NEKTON USE OF REGULARLY-FLOODED SALTMARSH CORDGRASS HABITAT IN NORTH CAROLINA, USA.
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
W. F. Hettler.
Marine Ecology Progress Series MESEDT, Vol. 56, No. 1-2, p 111-118, August 10, 1989. 7 fig, 1 tab, 22 ref.

Descriptors: *Salt marshes, *Wetlands, *Marshes, *Fish populations, *Species composition, Biomass, Spartina, Crustaceans, Estuaries.

Species composition, numbers and biomass of the nekton community on a regularly-flooded Spartina marsh near Beaufort, North Carolina, USA, was estimated for one year using modified 10 meter block nets. Thirty-five fish species dominated by mummichog Fundulus heteroclitus, spot Leiostomus xanthurus and pinfish Lagodon rhomboides were captured from the marsh surface. Numbers were greatest in April (1300 per 10 meters of marsh edge); biomass was greates in September (900 grams per 10 meters). Stream Order 1 (rivulet) marsh was occupied by fewer species, but contained greater numbers and biomass than Stream Order 3 (channel) marsh. (Author's abstract)
W90-02681

MOVEMENT AND HABITAT USE BY STREAM-DWELLING SMALLMOUTH BASS.
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
B. L. Todd, and C. F. Rabeni.
Transactions of the American Fisheries Society TAFSAI, Vol. 118, No. 3, p 229-242, May 1989. 5 fig, 7 tab, 37 ref.

Descriptors: *Fish behavior, *Radiotelemetry, *Bass, Rivers, Habitats, Seasonal variation, Remote sensing, Telemetry, Jacks Fork River, Missouri, Flooding, Water currents.

The movement and habitat use of 34 stream-dwelling smallmouth bass Micropterus dolomieui were monitored in Jacks Fork River, Missouri, by radiotelemetry. Observations were made 24 hours per day in all seasons. Definite patterns of diel activity and habitat use were evident and were modified by seasonal changes in water temperature. Fish remained in restricted home ranges for most of the year, but tended to disperse in spring when all of the radio-tagged fish left their home pool; 75% returned during the same season. Equal numbers of fish moved upstream and downstream. However, the median distance moved upstream was greater. Intrapool movement of smallmouth bass peaked soon after sunrise and again after sunset in all seasons. Average intrapool movement was 120 m/day when water temperatures were lowest (4 C) and 980 m/day when temperatures were highest (27.5 C). In the warmer seasons, fish preferred logjams and root wads by day and increased their use of boulders by night. In cooler seasons, fish used boulders almost exclusively. Regardless of season, open water without cover was used most during the period just after sunrise but was never used in proportion to its availability. Boulders were the most preferred substrate, and gravel was the least preferred. Smallmouth bass used intermediate depths the most and showed no daily or seasonal changes in depth preferences. Fish preferred velocities 0.2 m/sec at all times of day and in all seasons. Movements in floods did not differ from those observed during normal discharges; however, single logs were selected in significantly greater proportion than logjams. (Author's abstract)
W90-02686

INFLUENCE OF WATER QUALITY AND SEASON ON HABITAT USE BY STRIPED BASS IN A LARGE SOUTHWESTERN RESERVOIR.
Oklahoma Univ., Kingston. Biological Station.
W. J. Matthews, L. G. Hill, D. R. Edds, and F. P. Gelwick.
Transactions of the American Fisheries Society

TAFSAI, Vol. 118, No. 3, p 243-250, May 1989. 4 fig, 23 ref.

Descriptors: *Fish behavior, *Temperature effects, *Reservoirs, *Habitats, *Water quality, *Seasonal variation, Lake Texoma, Dissolved oxygen, Fish populations.

A large, multiyear (1981-1986) gillnetting data set was used to assess patterns of seasonal habitat use by striped bass Morone saxatilis in Lake Texoma, Oklahoma-Texas. Large (> 2.27 kg), medium (1.36-2.27 kg), and small (<1.36 kg but not including age-0 individuals) fish exhibited different patterns of seasonal abundance in a study area about 40 km uplake from the dam. Large fish were never taken in the study area in June, July, August or September, or when surface water temperatures exceeded 22 C. Abundance of medium-sized fish was significantly lower during June-September and when temperatures were above 22 C than in other months and at cooler temperatures. Small fish remained abundant in the uplake area all year, but were almost never collected at dissolved oxygen concentrations < 6.0 mg/L in summer. Substantial numbers of small fish were collected at temperatures as high as 29 C, but their catch per unit effort dropped from a mean of 11.8 per net at 28 C to 1.9 per net at 30 C. The results supported the thermal niche hypothesis for striped bass, and the response of small striped bass to high temperatures was similar to that reported previously. (Author's abstract)
W90-02687

ENVIRONMENTAL EFFECTS ON SURVIVAL OF EGGS, LARVAE, AND JUVENILES OF STRIPED BASS IN THE CHOPTANK RIVER, MARYLAND.
Maryland Dept. of Natural Resources, Annapolis. Chesapeake Bay Research and Monitoring Div.
J. H. Uphoff.
Transactions of the American Fisheries Society TAFSAI, Vol. 118, No. 3, p 251-263, May 1989. 5 fig, 6 tab, 47 ref.

Descriptors: *Water pollution effects, *Acid rain effects, *Maryland, *Choptank River, *Fish eggs, *Bass, *Rivers, Larvae, Water temperature, Rainfall, Spawning.

Eggs, larvae, and early juveniles of striped bass Morone saxatilis were sampled weekly from 1980 through 1985 in the Choptank River, Maryland. Yearly length-frequency distributions indicated variable survival of eggs and prolarvae (yolk-bearing larvae). Mortality of postlarvae (larvae that had absorbed their yolks) was 5-19% per day and was a decreasing function of larval size. Mortality of early juveniles was relatively low. Year-class success during 1980-1985 was significantly related to minimum water temperature during peak spawning periods and to rainfall during prolarvae. Rainfall apparently depressed postlarval survival by creating acidic, potentially stressful, and toxic conditions. (Author's abstract)
W90-02688

EFFECTS OF STATIC VERSUS FLOWING WATER ON AQUATIC PLANT PREFERENCES OF TRIPLOID GRASS CARP.
Agricultural Research Service, Davis, CA. Aquatic Weed Control Research Lab.
R. T. Pine, L. W. J. Anderson, and S. S. O. Hung.
Transactions of the American Fisheries Society TAFSAI, Vol. 118, No. 3, p 336-344, May 1989. 4 fig, 4 tab, 36 ref.

Descriptors: *Flow discharge, *Aquatic plants, *Carp, *Fish food, *Standing waters, Nutrition, Seasonal variation.

Triploid grass carp Ctenopharyngodon idella were presented with three aquatic plant species (sago pondweed Potamogeton pectinatus, Eurasian watermilfoil Myriophyllum spicatum, and American pondweed P. nodosus) in outdoor canals with static and flowing water in winter, spring and summer. Plant consumption by triploid grass carp in winter was low but increased dramatically in spring and summer. Based on plant shoot lengths,

triploid grass carp preferences in spring for static water were sago pondweed = American pondweed, American pondweed = Eurasian watermilfoil, sago pondweed > Eurasian watermilfoil; for flowing water, sago pondweed = Eurasian watermilfoil > American pondweed. Summer preferences for static water were sago pondweed = Eurasian watermilfoil = American pondweed. Plants of all three species produced longer shoots in canals with flowing water than with static water. The differences in shoot length may have altered the triploid grass carp's consumption rate and preference. Flowing conditions also had varying effects on nutritional content of plants, as shown in proximate analyses of dry matter and percent of fat, ash, protein, crude fiber, nitrogen free extract, and acid detergent fiber. Ash content was consistently higher in plants of all three species from canals with flowing water. This may reflect a morphological response to flow by the plants. None of the variables of the proximate analysis of plants correlated statistically with preference. This suggests that accessibility and ease of mastication were more important in determining preference than nutritional quality of the plants. Algae consumption by triploid grass carp, however, made it difficult to discern correlations between nutritional factors and vascular plant consumption. (Author's abstract)
W90-02691

VARIABILITY IN PHOTOSYNTHESIS: IMPACT ON DO MODELS.
Michigan Technological Univ., Houghton. Dept. of Civil Engineering.
M. T. Auer, and S. W. Effler.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 115, No. 5, p 944-963, October 1989. 8 fig, 1 tab, 60 ref.

Descriptors: *Photosynthesis, *Dissolved oxygen, *Light intensity, *Algae, Biomass, Light attenuation, Incident light, Water depth, Model studies, Graphs, Wasteload allocation models, River systems.

The methodology presented for quantifying the net contribution by algae to the oxygen resources of rivers recognizes natural variation in incident light as a key factor mediating the character and magnitude of the algal source-sink term. Required input data include algal biomass, the light attenuation coefficient, daily average incident light, river depth, and the relationship between net oxygen production and light. Systems that are particularly sensitive to algal metabolism, and therefore incident light, are those with high plant biomass, light attenuation, depth, and low reaeration. Graphical relationships are applied as screening tools to identify potentially sensitive river environments on the basis of incident light, light attenuation, and depth. Example calculations show that failure to accommodate natural variation in incident light in wasteload allocation models may impart substantial uncertainty to model output. This methodology permits calculation of oxygen deficits over the natural range in incident light values and thus can serve to improve the credibility of management actions when used as a screening tool. Incorporation of these concepts into existing wasteload allocation models seems necessary and useful. (Author's abstract)
W90-02719

EFFECT OF POND DEPTH ON BACTERIAL MORTALITY RATE.
Dar es Salaam Univ. (Tanzania). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-02720

IMPORTANCE OF PHYSICAL VARIABLES ON THE SEASONAL DYNAMICS OF EPILITHIC ALGAE IN A HIGHLY SHADED CANYON STREAM.
Northern Arizona Univ., Flagstaff. Dept. of Biology.
S. W. Duncan, and D. W. Blinn.
Journal of Phycology JPYLAJ, Vol. 25, No. 3, p 455-461, September 1989. 2 fig, 1 tab, 42 ref.

Descriptors: *Seasonal variation, *Arizona, *Diatoms, *Algae, *Stream biota, *Periphyton, Temperature, Light intensity, Chemical analysis, Cyanophyta, Chlorophyta, Nutrients, Biomass, Regression analysis, Correlation analysis.

The seasonal abundance of epilithic algae was correlated with major physico-chemical parameters in a first-order, heavily shaded stream in northern Arizona. Diatoms made up over 85%, by numerical abundance, of the epilithon community. Light energy, water temperature, and stream discharge were most highly correlated with seasonal abundance of epilithic diatom taxa when analyzed with stepwise multiple regression. None of the chemical variables measured in the study (NO3-N, O-PO4, SiO2, including pH) was found to be significantly correlated with the seasonal community structure of epilithic diatoms. Total diatom cell densities showed a significant negative correlation to stream bed light energy. Likewise, total diatom cell densities along a transect in the stream bed showed a negative correlation to current velocity during those months when base flow was low and stable, and current velocity was < or = 25 cm/sec. Most diatom taxa had highest cell densities at temperatures <16 C and at daily mean stream bed light levels <400 microE/sq m/s. Highest cell densities of green algae occurred at temperatures between 6-16 C and at daily mean stream bed light levels of >400 microE/sq m/s. Blue-green algae (cyanobacteria) grew best at the highest recorded water temperatures and daily mean stream bed light energy (16-20 C and 900-1200 microE/sq m/s). Abrupt increases in NO3-N coincided with a brief pulse of Nostoc pruniforme colonies during June, and leaf drop from Alnus oblongifolia during October. (Author's abstract)
W90-02727

RESPONSES OF THE ACIDOPHILIC ALGA EUGLENA MUTABILIS (EUGLENOPHYCEAE) TO CARBON ENRICHMENT AT PH 3.
Toronto Univ. (Ontario). Dept. of Botany.
For primary bibliographic entry see Field 5C.
W90-02728

LATE QUATERNARY PALEOLIMNOLOGY OF WALKER LAKE, NEVADA.
Geological Survey, Denver, CO.
J. P. Bradbury, R. M. Forester, and R. S. Thompson.
Journal of Paleolimnology, Vol 1, No. 4, p 247-267, 1988/89. 11 fig, 1 tab, 34 ref. Department of Energy/Geological Survey Interagency Agreement DE-AI08-78ET44802.

Descriptors: *Walker Lake, *Paleolimnology, *Saline lakes, *Nevada, Closed basins, Climatic changes, Lake sediments.

Paleolimnological evidence (diatoms, crustaceans, and pollen from sediment cores) suggests that the Walker Lake basin in Nevada contained a relatively-deep and slightly-saline to freshwater lake before ca 30,000 years B.P. During the subsequent drawdown, the Walker River shifted its course and flowed northward into the Carson Sink. As a result, the lake shallowed and became saline. During the full glacial, cooler climates with more-effective moisture supported a shallow brine lake in the basin even without the Walker River. As glacial climates waned 15,000 years ago, Walker Lake became a playa. The Walker River returned to its basin 4700 years ago, filling the lake with fresh water in a few decades. Thereafter, lake salinity and depth increased as evaporation concentrated inflowing water, until by 3000 years ago Walker Lake was nearly 90 m deep. According to dated shoreline tufas, lake levels fluctuated throughout this interval in response to variations in Sierra Nevada precipitation and local evaporation. A drought in the Sierras 2000-2400 years ago reduced Walker Lake to a shallow, brine lake. Climate-controlled refilling of the lake starting 2000 years ago required about one millennium to bring Walker Lake near its historic level. (Author's abstract)
W90-02729

Group 2H—Lakes

PERIODS OF RAPID ENVIRONMENTAL CHANGE AROUND 12500 AND 10000 YEARS B.P., AS RECORDED IN SWISS LAKE DEPOSITS.
Bern Univ. (Switzerland). Systematisch-Geobotanisches Inst.
B. Ammann.
Journal of Paleolimnology, Vol. 1, No. 4, p 269-277, 1989. 4 fig, 41 ref.

Descriptors: *Paleolimnology, *Climatology, *Glacial lakes, *Lake sediments, *Switzerland, *Stratigraphy, Radioactive dating, Climatic changes.

In the sediments of three Swiss Lakes ranging in altitude from 514 to 2017 m, the Boelling and the Preboreal are recognized as two periods of rapid biotic changes. Rapid climatic change triggered shifts to different groups of aquatic and terrestrial organisms. Although these groups were expected to have very different response times (e.g., to increasing summer temperature), their assemblages responded with surprising syncroneity. For extracting climatic signals from stratigraphies, quickly-responsive indicators, like oxygen isotopes or beetles, are useful. For understanding ecological dynamics under a changing climate, comparison of biota with various response times is important. (Author's abstract)
W90-02730

CATCHMENT DISTURBANCE INFERRED FROM PALEOLIMNOLOGICAL STUDIES OF THREE CONTRASTED SUB-HUMID ENVIRONMENTS IN MOROCCO.
University Coll., London (England). Palaeoecology Research Unit.
For primary bibliographic entry see Field 4C.
W90-02731

INTER- AND INTRALAKE DISTRIBUTIONS OF TRACE ORGANIC CONTAMINANTS IN SURFACE WATERS OF THE GREAT LAKES.
Inland Waters Directorate, Burlington (Ontario). Water Quality Branch.
For primary bibliographic entry see Field 5B.
W90-02745

PHOTOSYNTHETIC CHARACTERISTICS OF PHYTOPLANKTON COMMUNITIES IN LAKES HURON AND MICHIGAN: P-I PARAMETERS AND END-PRODUCTS.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
G. L. Fahnenstiel, J. F. Chandler, H. J. Carrick, and D. Scavia.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 3, p 394-407, 1989. 8 fig, 5 tab, 53 ref.

Descriptors: *Limnology, *Photosynthesis, *Great Lakes, *Phytoplankton, *Lake Huron, *Lake Michigan, Carbon, Light intensity, Seasonal variation, Diurnal distribution, Proteins, Lipids, Polysaccharides.

Photosynthetic-irradiance (P-I) curves and partitioning of photosynthate into major end-products (protein, lipids, polysaccharides, and low molecular weight (LMW) metabolites) were examined for phytoplankton communities from Lakes Huron and Michigan. The mean and variance of P-I parameters and photosynthetic end-products were similar in both lakes. Mean PM(B) (maximum light saturated rate) and alpha (initial linear slope) values were 2.3 mg C/mg Chl/h and 5.5 mg C/mg Chl/Einst sq m for Lake Huron communities, and 2.4 mg C/mg chl/h and 7.0 mg C/mg chl/Einst sq m for Lake Michigan communities. Over longer incubations the activity in each end-product increased linearly during the day; during the night the activity in the LMW and polysaccharide fractions decreased and the activity in the protein fraction increased. There were significant seasonal variation in P-I parameters and photosynthetic end-products. In both lakes, phytoplankton communities from the late winter-spring isothermal period were characterized by lower PM(B) values, higher alpha values, significant susceptibility to photoinhibition, and less incorporation into protein, as compared to communities from periods when the lakes were thermally stratified. (Author's abstract)
W90-02746

PREDATION BY COELOTANYPUS (DIPTERA: CHIRONOMIDAE) ON LABORATORY POPULATIONS OF TUBIFICID OLIGOCHAETES.
DePauw Univ., Greencastle, IN. Dept. of Geology and Geography.
F. M. Soster, and P. L. McCall.
Journal of Great Lakes Research JGLRDE, Vol 15, No. 3, p 408-417, 1989. 4 fig, 7 tab, 24 ref. NSF Grant No. OCE 80-05103, National Oceanographic and Atmospheric Administration Grant No. NA80RAD00036.

Descriptors: *Limnology, *Lake Erie, *Midges, *Tubificids, *Predation, Larvae, Populations, Density, Simulation analysis, Distribution.

Laboratory experiments were conducted with sediments and organisms collected from Lake Erie's western basin to examine the effect of Coelotanypus (Chironomidae: Diptera) predation on tubificid oligochaetes. Populations of predator and prey organisms were kept together in replicate laboratory microcosms at densities ranging from 2,500-12,500 predators/sq m and 12,500-62,500 prey/sq m for 15-day to 30-day periods. Control populations of predators and prey were maintained separately for comparative purposes. A separate selection experiment showed that larvae preferred sediments containing tubificids or previously settled larvae over sediments that contained neither. Mortality in worm populations kept with predatory Coelotanypus larvae averaged 56.9% (S.D. = 3.9%) and was significantly higher (p <0.001, t-test) than the 9.7% (S.D. = 3.1%) average mortality in control populations. Simulated effects of chironomid burrowing and burrow irrigation did not cause increased worm mortality. An average predation rate of 0.11 (S.D. = 0.04) prey/predator/day was calculated from the data. Based on average Coelotanypus and tubificid densities in western Lake Erie and assuming that natural feeding rates are comparable to those in the laboratory, Coelotanypus may be capable of reducing tubificid populations by about 20% over a 2-month period during the late summer. Natural abundance data indicate that tubificid population declines are associated with periods of peak Coelotanypus density. (Author's abstract)
W90-02747

CHARACTERISTICS OF OHIO'S LAKE ERIE RECREATIONAL MARINAS.
Ohio Cooperative Extension Service, Painesville.
For primary bibliographic entry see Field 6D.
W90-02748

ESTIMATES OF MACROINVERTEBRATE BIOMASS IN LAKE MICHIGAN.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
T. F. Nalepa.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 3, p 437-443, 1989. 2 fig, 4 tab, 38 ref.

Descriptors: *Limnology, *Great Lakes, *Lake Michigan, *Macroinvertebrates, Biomass, Oligochaetes, Seasonal variation, Depth.

To obtain updated, more accurate estimates of macroinvertebrate standing stocks in Lake Michigan, benthic biomass (ash-free dry weight) was determined at 40 stations in the southern end of the lake in 1980 and 1981. Biomass generally increased as sampling depth increased from 16 to 30 m, peaked at depths of 30-40 m, and then declined at depths greater than 40 m. Mean total biomass at the 16-30 m, 31-50 m, 51-90, and > 90 m depth intervals was 4.9, 7.8, 4.2, and 1.9 g sq m, respectively. Oligochaetes (46%) and Pontoporeia hoyi (44%) accounted for most of the biomass at depths shallower than 30 m, but P. hoyi was the dominant form (65%) at depths greater than 30 m. Differences in total biomass between years and seasons (spring, summer, fall) were not significant, but year x season interaction was significant at depths greater than 30 m. Mean biomass in the profundal of southern Lake Michigan (>90 m) was over twice that found in the profundal of either Lakes Superior, Huron, or Ontario. (Author's abstract)
W90-02750

MODELING WIND-INDUCED WATER SETUP IN LAKE ST. CLAIR.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
T. J. Simons, and W. M. Schertzer.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 3, p 452-464, 1989. 5 fig, 4 tab, 13 ref.

Descriptors: *Limnology, *Seiches, *Wind tides, *Water level, *Lakes, *Wind, Lake Saint Clair, Wind velocity, Hydrodynamic models, Bottom stress.

Water level measurements at Belle River and St. Clair Shores from 1 June to 30 November 1985 are used to verify simulations of wind-induced water setup obtained from a two-dimensional hydrodynamic model of Lake St. Clair. The wind drag coefficient is estimated as a function of stability and wind speed by correlating observed and computed water levels under various atmospheric conditions. Effects of different bottom stress formulations are investigated by considering the balance of forces along the setup line between Belle River and St. Clair Shores. The setup computed by a hydrodynamic model for a given wind stress may vary by as much as 50% depending on the formulation of the bottom stress, and the wind drag coefficient varies strongly with the type of bottom stress used in the model. The hydrodynamic model produces a correlation coefficient, r = 0.92, between hourly values of computed and measured setup. Comparison of results with empirical relationships between wind and water level changes produce similar results. (Author's abstract)
W90-02752

MONITORING OF TRACE ORGANIC CONTAMINANTS IN ATMOSPHERIC PRECIPITATION.
Inland Waters Directorate, Burlington (Ontario). Water Quality Branch.
For primary bibliographic entry see Field 7B.
W90-02753

CLIMATOLOGY OF SEDIMENT TRANSPORT ON INDIANA SHOALS, LAKE MICHIGAN.
Argonne National Lab., IL. Biological, Environmental, and Medical Research Div.
For primary bibliographic entry see Field 2J.
W90-02755

PARTITIONING AND TRANSPORT OF 210PB IN LAKE MICHIGAN.
Wisconsin Univ.-Madison. Water Chemistry Program.
For primary bibliographic entry see Field 5B.
W90-02756

ANTHROPOGENIC IMPACTS ON SNIARDWY LAKE (POLAND).
Wroclaw Technical Univ. (Poland). Inst. of Inorganic Chemistry and Metallurgy of Rare Elements.
For primary bibliographic entry see Field 5A.
W90-02757

UNIQUE LIMNOLOGICAL PHENOMENA AFFECTING WATER QUALITY OF HAMILTON HARBOUR, LAKE ONTARIO.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 5B.
W90-02758

DIRECT PHENOTYPIC AND GENOTYPIC DETECTION OF A RECOMBINANT PSEUDO-

MONAD POPULATION RELEASED INTO LAKE WATER.
Liverpool Univ. (England). Dept. of Genetics and Microbiology.
For primary bibliographic entry see Field 5B.
W90-02786

MICROBIAL DEGRADATION OF SEVEN AMIDES BY SUSPENDED BACTERIAL POPULATIONS.
Environmental Protection Agency, Athens, GA. Southeast Environmental Research Lab.
For primary bibliographic entry see Field 5B.
W90-02787

DEVELOPMENT OF A SOLID MEDIUM FOR GROWTH AND ISOLATION OF AXENIC MICROCYSTIS STRAINS (CYANOBACTERIA).
Ibaraki Univ., Ami (Japan). Dept. of Agricultural Chemistry.
For primary bibliographic entry see Field 7B.
W90-02788

CHARACTERIZATION OF TOXIGENIC VIBRIOS ISOLATED FROM THE FRESHWATER ENVIRONMENT OF HIROSHIMA, JAPAN.
Hiroshima Univ. (Japan). Dept. of Food Microbiology and Hygiene.
For primary bibliographic entry see Field 5A.
W90-02789

CONSERVING RIVERS IN SOUTHERN AFRICA.
Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
For primary bibliographic entry see Field 2E.
W90-02809

CORRELATION OF ENVIRONMENTAL VARIABLES WITH PATTERNS OF DISTRIBUTION AND ABUNDANCE OF COMMON AND RARE FRESHWATER MACROINVERTEBRATES.
Commonwealth Scientific and Industrial Research Organization, Lyneham (Australia). Div. of Wildlife and Ecology.
D. P. Faith, and R. H. Norris.
Biological Conservation BICOBK, Vol. 50, p 77-98, 1989. 1 fig, 1 tab, 53 ref.

Descriptors: *Limnology, *Ecology, *Australia, *Macroinvertebrates, *Species diversity, Correlation analysis, LaTrobe River, Water chemistry, Rare species, Distribution, Abundance, Stream order.

The environmental factors underlying variation in abundance of common and rare freshwater taxa are examined. Hybrid multidimensional scaling is used to model variation in distribution and abundance of freshwater macroinvertebrate taxa over 17 sample sites in the upper catchment of the LaTrobe River, Victoria, Australia. Initial analysis of 40 common taxa revealed high correlations of the ordination space with physico-chemical variables related to temperature, stream order, particle size and water chemistry. Analysis of all 269 taxa, or alternatively of the 229 rarer taxa alone, resulted in ordination spaces that showed high correlations for additional physico-chemical variables, particularly relating to water chemistry. Monte Carlo significance tests supported this finding in demonstrating that the analysis of all taxa produced a greater number of significant correlations between the ordination space and physico-chemical variables. The additional important environmental correlates revealed by the analysis of the rare taxa suggested that there might be differences in the set of environmental variables that are related to patterns of distribution and abundance of rare versus common taxa. The recovery of additional environmental correlates with the inclusion of rare taxa has implications for conservation studies at the community level. Ordination can be used for survey extension where complete information on distribution and abundance of taxa is unavailable. The ability of ordination methods to summarize distribution and abundance of rare taxa, and incorporate their additional information on environmental variation, suggests

that representativeness of the ordination space is a useful criterion for reserve selection. (Author's abstract)
W90-02811

MASS MORTALITY OF SALAMANDERS (AMBYSTOMA TIGRINUM) BY BACTERIA (ACINETOBACTER) IN AN OLIGOTROPHIC SEEPAGE MOUNTAIN LAKE.
Aspen Antibodies, Inc., McCammon, ID.
For primary bibliographic entry see Field 5C.
W90-02817

SUCCESSION PATTERNS OF PHYTOPLANKTON BLOOMS: DIRECTIONALITY AND INFLUENCE OF ALGAL CELL SIZE.
Instituto de Ciencias del Mar, Barcelona (Spain).
For primary bibliographic entry see Field 2L.
W90-02821

SPATIAL AND TEMPORAL VARIATION IN THE STRUCTURE OF A FRESHWATER FOOD WEB.
York Univ. (England). Dept. of Biology.
P. H. Warren.
OIKOS OIKSAA, Vol. 55, No. 3, p 299-311, Jul 1989. 6 fig, 3 tab, 47 ref.

Descriptors: *Limnology, *Food chains, *Macroinvertebrates, *Ponds, Detritus, Ecology, Seasonal variation, Model studies, Predation, Gut analysis, Species diversity, Feeding.

Trophic interactions between benthic invertebrates in a large freshwater pond were established using analyses of gut contents, laboratory feeding trials and published information. The web was detritus based and contained 36 'species'. Spatial and temporal variation in food web structure was assessed by partitioning the overall food web into subwebs drawn up for two areas of the pond on each of five sampling dates over the course of a season. Substantial variation occurred between webs from the open water benthos and the pond margin areas, both within and between sampling dates. Webs became more complex (species rich) over the season and, within, the webs from each area, species composition and interactions varied due to body size and life history effects. In relation to published data the webs had high average connectance, high proportions of intermediate species (and links among intermediate species) and moderately high predator: prey ratios. Omnivory was extensive and, due to size dependent predation, cannibalism and trophic loops occurred. The potential effects of spatial and temporal variation in the web on the dynamics of trophic interactions suggest that Cohen and Newman's 'cascade model' which imposes simple, non-dynamic constraints on the distribution of trophic interactions, may be an appropriate explanation for web structure. However, simulated webs generated by the cascade model, using parameters derived from the webs in this study, indicated the model's sensitivity to connectance, and suggested that, in its present form, the model adequately accounts for the proportions of basal, top and intermediate species, but may not be a sufficient explanation for observed food chain lengths. (Author's abstract)
W90-02824

BATHYMETRIC DISTRIBUTION AND ABUNDANCE OF PISIDIUM (BIVALVIA: SPHAERIIDAE) IN LAKE ESROM, DENMARK, FROM 1954 TO 1988.
Joensuu Univ. (Finland). Dept. of Biology.
I. J. Holopainen, and P. M. Jonasson.
OIKOS OIKSAA, Vol 55, No. 3, p 324-334, Jul 1989. 11 fig, 2 tab, 49 ref.

Descriptors: *Limnology, *Mollusks, *Lakes, *Clams, *Denmark, Eutrophication, Pisidium, Sphaerium, Species diversity, Biomass, Water depth, Population dynamics.

Results of 34 years of routine sampling at different depths in Lake Esrom, in Denmark, are used to describe temporal changes in density and bathymetric distribution of Pisidium spp. Totals of 11

Pisidium and 2 Sphaerium species have been reported from Lake Esrom. After low densities (annual mean of 200-400 ind/sq m) reported in 1930s, a ten-fold increase in twenty years is shown at 11-20 m with peak numbers in 1957 (3,000-4000 ind/sq m). Since then a decline back to ca. 300-500 ind/sq m took place before 1980. This was accompanied by a decrease in species diversity. In 1982-1988 Pisidium was found at densities of only 100-200 ind/sq m. At 2 m depth a mean annual number of ca. 900 ind/sq m in 1930s has increased up to 3000-4000 in 1980. This corresponds to a mean annual biomass of 200-300 mg ash free dry weight. The long-term changes are thought to be due to eutrophication. Pisidium being first favored by the increasing nutrient level and then harmed by the deterioration of living conditions, e.g. long periods of oxygen depletion in and close to the profundal sediments. The variability of population densities did not clearly increase with the length of the period used in their calculation. (Author's abstract)
W90-02825

DISTRIBUTION AND BIOMASS OF AQUATIC MACROPHYTES IN AN ABANDONED NUCLEAR COOLING RESERVOIR.
Georgia Univ., Athens. Inst. of Ecology.
M. S. Kelly.
Aquatic Botany AQBODS, Vol. 35, No. 2, p 133-152, Oct 1989. 3 fig, 1 tab, 18 ref. Dept of Energy contract DE-AC09-76SR00-819.

Descriptors: *Limnology, *Aquatic populations, *Macrophytes, *Cooling ponds, Floating plants, Rooted aquatic plants, Coastal plains habitats, Acidic water, Submerged plants, Chemical properties, Conductivity.

Pond B is an 87-ha abandoned reactor cooling reservoir on the Savannah River Plant, South Carolina. Since abandonment in 1964, the reservoir has reverted to a low conductivity and slightly acidic water chemistry, and has also been colonized by abundant macrophyte vegetation. To determine dominant species and their depth distributions, and to estimate seasonal changes in standing crop, above-sediment biomass of macrophyte vegetation was sampled at four water depths three times during the 1986 growing season. Three floating-leaved species, Nymphaea odorata Ait., Brasenia schreberi and Nymphoides cordata comprised 51.8% of biomass harvested, with greatest biomass at 1.5 m and in the October sampling. Free-floating Utricularia species (mostly U. floridana Nash) contributed 32% of harvested biomass, were abundant at all sampling depths and had greatest standing crop in May. Submersed rooted species comprised 15.4% of biomass harvested, dominated by Cabomba caroliniana var. pulcherrima Harper in deeper portions of the littoral zone. The species composition found in Pond B was similar to that of aquatic plant communities in other softwater Coastal Plain habitats (such as Carolina Bay ponds and rain-fed swamps), and differed from species composition reported for Par Pond, a neighboring reservoir with higher conductivity. These comparisons suggested that differences in water chemistry may have been important in determining establishment of macrophyte species in these two reservoirs. (Author's abstract)
W90-02832

FREMONT LAKE, WYOMING--SOME ASPECTS OF THE INFLOW OF WATER AND SEDIMENT.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 2J.
W90-02849

NUTRIENT DIFFUSION AND KINETIC LIMITATIONS IN BIOFILMS.
Technology Applications, Inc., Athens, GA.
D. K. Gattie, and D. L. Lewis.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-124424. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-88/238, November 1988. 12p, 3 fig, 7 ref.

Group 2H—Lakes

Descriptors: *Nutrients, *Biofilms, *Diffusion, *Substrates, *Model studies, Kinetics, Mathematical models, Biotransformation.

Substrate removal rates of biofilms, which occur at sediment-water interfaces and on other submerged aquatic surfaces, depend on whether the rates are predominantly limited by diffusion rates of the substrate to and into the biofilms or by the kinetics of microorganisms that remove the substrate from solution. A reasonable understanding of the interrelationship of these processes requires a knowledge of how diffusion limitation affects species diversity and, therefore, the ultimate kinetic limitations of biofilms to transform a substrate. Mathematical models designed to predict removal rates under field conditions must incorporate a capability to predict whether diffusion or microbial kinetics will dominate substrate removal rates for a particular substrate under a particular set of environmental conditions. A possible solution to this modeling problem involves the use of subroutines to estimate diffusion rates to compare with microbial transformation rates based on laboratory-determined rate coefficients for kinetically limited substrate removal rates of blended biofilm samples. (Author's abstract)
W90-02922

SHALLOW WATER WAVE EQUATIONS ON A VECTOR PROCESSOR.
Notre Dame Univ., IN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W90-03015

TESTING OF FINITE ELEMENT SCHEMES FOR LINEAR SHALLOW WATER EQUATIONS.
Vatnaskil, Reykjavik (Iceland).
S. P. Kjaran, S. L. Holm, and S. Sigurdsson.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 249-256, 6 fig, 1 tab, 2 ref.

Descriptors: *Surface flow, *Statistical methods, *Model studies, *Shallow water equations, *Surface water, *Finite element method, *Free surfaces, *Hydraulic models, Wind stress, Friction, Coriolis force, Mathematical models, Finite difference methods, Staggered finite element scheme, Shallow water, Performance evaluation, Mathematical analysis, Water level.

The problem of testing finite-element schemes for shallow-water free surface flow, including the effects of friction, wind stress, and Coriolis force was examined using the new staggered finite-element scheme introduced in 1988 by Sigurdsson and associates (W90-03027). By neglecting non-linear terms in shallow-water equations, they can be reduced to a Helmholtz equation by considering periodic or time-independent solutions. When only effects of friction and wind stress are included, there exist analytical solutions for simple geometries that lend themselves to comparisons with solutions obtained with finite-element schemes. However, when the effect of Coriolis force is also present, analytical solutions become more complicated, even in simple geometries, due to awkward boundary conditions. For this case, it is proposed that a simple finite-difference scheme be used for comparisons with finite-element solutions. Because all the difference approximations can be made to be of second order for simple geometries, a posteriori error estimates for the finite-difference solutions are available via extrapolation. The staggered finite-element scheme of Sigurdsson and associates was tested in a problem involving a rectangular mesh of 40 x 40 km, with 289 nodes and an element size of 2500 m. A polar case was tested in which there were 90 nodes and elements divided radially into 5-degree intervals; the length along a radius in this problem was 30 km. In these problems the no-flow boundary was on three sides. Wind set-up, water level, and

velocity results were very close between the finite-difference and finite-element methods, except when the Coriolis effect was introduced, in which case water level results differed considerably between the finite-difference and finite-element approaches. (See also W90-02980) (Rochester-PTT)
W90-03016

COUPLED FINITE DIFFERENCE-FLUID ELEMENT TRACKING METHOD FOR MODELLING HORIZONTAL TRANSPORT IN SHALLOW LAKES.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
P. Bakonyi, and J. Jozsa.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 289-294, 5 fig, 2 ref.

Descriptors: *Hungary, *Lakes, *Shallow water, *Statistical models, *Wind-driven currents, *Model studies, *Finite difference methods, Fluid element tracking, Lake Balaton, Computer programs, Performance evaluation, Advection, Diffusion, Monte Carlo method.

Wind-induced horizontal transport phenomena were analyzed in shallow lakes using a coupled two-dimensional circulation-fluid element tracking model. Advective currents were calculated by depth-integrated alternating direction implicit (ADI)-type finite-difference model. In subdomains the influence of small-scale bottom topography on the velocities is taken into account by local grid refinement. To avoid numerical diffusion and to obtain qualitative results quickly and easily, transport simulation is based on the Lagrangian Fluid Element Tracking method, modelling the paths of marked fluid elements in the advective-diffusive velocity field. Diffusive velocity fluctuations were generated by Monte Carlo techniques. Applications of this model are illustrated here as simulation of storm-induced displacement of large pollution clouds, water exchange in bays, and the mixing of inflow in Lake Balaton, Hungary. The accuracy can be improved using higher order time integration and velocity interpolation. Quantitative results can be obtained by increasing the number of elements, resulting in a linear increase in CPU time. Further improvements should include a three-dimensional extension and the direct use of velocity fluctuation data. (See also W90-02980) (Rochester-PTT)
W90-03021

SOLVING THE TRANSPORT EQUATION USING TAYLOR SERIES EXPANSION AND FINITE ELEMENT METHOD.
Systech Engineering, Inc., Lafayette, CA.
C. L. Chen.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 301-306, 1 fig, 10 ref.

Descriptors: *Numerical analysis, *Model studies, *Shallow water, *Finite element method, *Transport equation, Taylor series, Convection, Diffusion, Mathematical equations, Mathematical models, Algorithms, Numerical analysis, Computer programs, Finite element method, Galerkin method, Lakes, Surface water.

The simulation of transport problems in a shallow-water basin requires the solution of the depth-averaged transport equation. A numerical scheme is presented to obtain the solution of the depth-averaged convection-diffusion (transport) equation together with the shallow water equations. The Galerkin finite-element method is applied to the spatial approximation of the transport equation. The direct use of Taylor series expansion to the

second order derivative in the time domain results in a simple forward time-stepping scheme. This scheme introduces balancing tensor diffusivities into the transport equation to compensate for the truncation error due to forward differencing in time, and it precludes spurious oscillations. Computational efficiency can be obtained by lumping the mass matrix and using one-point quadrature. The scheme is conditionally stable and second-order accurate. (See also W90-02980) (Author's abstract)
W90-03023

COOLING-INDUCED NATURAL CONVECTION IN A TRIANGULAR ENCLOSURE AS A MODEL FOR LITTORAL CIRCULATION.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
G. M. Horsch, and H. G. Stefan.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 307-312, 4 fig, 11 ref.

Descriptors: *Nearshore processes, *Water circulation, *Convection, *Heat transfer, *Model studies, *Littoral zone, Numerical analysis, Algorithms, Patankar computer program, Simulation, Mathematical models, Mathematical equations, Water temperature, Lakes.

In many environmental water resources applications, the flow is excited by heat transfer through the surface of the water body. The convective flow is driven by a horizontal temperature (density) gradient, which forms because regions of progressively larger depth are subjected to approximately the same rate of surface cooling. In the convective littoral flow the horizontal temperature gradient develops naturally in response to heat transfer in the vertical. The present simulation model is formulated in terms of the equations of continuity, momentum, and energy, all expressed in polar coordinates, in which the domain can be fitted naturally. Because the domain is cooled from the surface, while the bottom and the side are insulated, the water temperatures continue to drop and no steady state in terms of temperatures can be achieved. The conservation equations were discretized in primitive variables and solved numerically using the SIMPLE algorithm. The main features of the method are preservation of the conservation properties of the equations, the power-law interpolation of the combined convection-diffusion fluxes, and fully implicit time-marching. The method was implemented in the code of Patankar, with modifications to allow calculation of unsteady flow. Numerical solutions at Rayleigh numbers (Ra) of 10,000, 1,000,000, and 100,000,000 and Prandtl number = 7 (water at 20 C), with slope = 0.2, were extracted. The initial condition was an isothermal, zero-velocity body of water. The steady state at Ra = 1,000,000 consists of one main cell, with a smaller cell near the surface of the deep-end side. At dimensionless times on the order of 400 to 500, temperatures reached a steady state for practical purposes, but velocities still oscillated, to be damped out later. The evolution of the Ra = 100,000,000 run was considerably more complicated; the steady state may be reached here only in a time-averaged sense. (See also W90-02980) (Rochester-PTT)
W90-03024

LAYERED WAVE EQUATION MODEL FOR THERMALLY STRATIFIED FLOW.
Vermont Univ., Burlington. Dept. of Civil and Mechanical Engineering.
J. P. Laible.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southamp-

ton (co-publishers). 1988. p 319-327, 4 fig, 8 ref.

Descriptors: *Internal waves, *Stratified flow, *Model studies, *Lake Champlain, *Thermal stratification, *Wind pressure, *Thermocline, *Lakes, *Mathematical models, Hydraulic models, Differential equations, New York, Vermont, Waves, Prediction.

Large amplitude internal waves exist in lakes in temperate climates when thermal stratification develops in the summer months. This motion can induce substantial flows under the right wind conditions and hence can play a significant role in the transport process in the main body of a lake. Extension of the wave equation form of differential equations for homogeneous bodies of water to a two-layered system was done with particular reference to Lake Champlain (New York/Vermont). The form of the general equations is described and a special (X-Z problem) case is detailed. The resulting model was applied to predict motion of the thermocline in Lake Champlain. The solution of the resulting matrix equations was obtained by both direct numerical integration and modal analysis. Lake Champlain is a long, narrow body of water with a thalweg length of 73.6 km. In the present work vertically integrated equations were used and the Coriolis and convective terms were ignored. The thalweg is the x axis and the z axis is downward. With the lake initially at rest, wind stress values were read into the program at 1-hr increments. The modeled and measured response were agreed well. The modeled amplitudes were less than the observed. The amplitude of the motion was quite large, reaching 20-25 m. This large motion followed a strong wind event and resulted in tremendous horizontal exchanges of fluid. The modal analysis revealed that the fundamental period of motion is 3.51 days. Frequency analysis of the thermocline motion data provides a period of 3.6 days. When all modes are included, the modal analysis and direct time integration method produced identical results, as expected. When only the first five large period anti-gradient modes are used, the results are unreasonable and eventually become excessive. (See also W90-02980) (Rochester-PTT)
W90-03026

SIMPLE STAGGERED FINITE ELEMENT SCHEME FOR SIMULATION OF SHALLOW WATER FREE SURFACE FLOWS.
Iceland Univ., Reykjavik. Science Inst.
S. Sigurdsson, S. Kjaran, and G. G. Tomasson.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 329-335, 2 fig, 6 ref.

Descriptors: *Simulation analysis, *Surface flow, *Model studies, *Shallow water, *Free surfaces, *Finite element method, Staggered finite element scheme, Mathematical equations, Mathematical models, Hydraulic models, Simulation, Performance evaluation.

Numerical schemes for simulation of free surface flows that employ the idea of replacing the first order continuity equation with the second order wave equation recently have received considerable attention. An analogous approach is presented here in which a finite element approximation in space to the continuity equation is first derived and then this approximate equation is differentiated in time and combined with the momentum equations. Although the resulting equation can be viewed as a space approximation to the wave equation, the present approach simplifies the derivation with respect to boundary conditions and offers added insight into the treatment of non-linear terms. Based on this approach a finite-element scheme for the shallow water equations is derived that uses linear approximations over triangular elements for surface elevation but piecewise constant approximations for the velocity components within the elements. The resulting scheme resembles finite-difference schemes based on the so-called stag-

gered grid approach, so it is referred to as the staggered finite element (SFE) scheme. The computational attraction of the SFE scheme is that, in the absence of convective terms, and for a given approximation to the elevation values, the momentum equations can be integrated independently within the elements. By treating the discontinuities in the approximate velocity values across element boundaries appropriately, it is nonetheless found that the scheme is sufficiently accurate for many simulations. In the tests carried out so far, various simplifications have been employed to ensure that the matrix to be inverted when advancing one timestep will be positive, definite, and independent of time so that it is necessary only to carry out a Cholesky factorization at the beginning and when the timestep is changed. (See also W90-02980) (Rochester-PTT)
W90-03027

IMPROVED STABILITY OF THE 'CAFE' CIRCULATION MODEL.
National Technical Univ., Athens (Greece). Dept. of Civil Engineering.
E. A. Zeris, and G. C. Christodoulou.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 337-342, 3 fig, 1 tab, 8 ref.

Descriptors: *Finite element method, *Water circulation, *Statistical models, *Model studies, *Shallow water, Hydraulic models, Advection, Finite difference methods, Numerical analysis, CAFE model, Model testing, Wave propagation, Performance evaluation.

One of the earliest and best known finite-element solution schemes for the shallow water equation (SWE) is the one developed by Wang and Conner and known by the acronym CAFE. The CAFE finite-element scheme for the shallow water equations is shown to be non-linearly unstable due to the type of discretization applied the advective terms. The behavior of CAFE with respect to its non-linear instability is markedly similar to that of a class of similarly structured finite-difference schemes for the SWE. An improved, two-step, time integration scheme is proposed that stabilizes advection. Its efficacy has been verified by simple numerical experiments (a free oscillation test, with the model equations containing only the wave propagation and the advective terms). The scheme remained stable for Courant numbers 0.2-0.8, but not 1.0. (See also W90-02980) (Rochester-PTT)
W90-03028

PRACTITIONER'S HANDBOOK ON THE MODELLING OF DYNAMIC CHANGE IN ECOSYSTEMS.
Institute of Terrestrial Ecology, Grange over Sands (England). Merlewood Research Station.
For primary bibliographic entry see Field 6G.
W90-03198

PROTOZOAN GRAZING AND BACTERIAL PRODUCTION IN STRATIFIED LAKE VECHTEN ESTIMATED WITH FLUORESCENTLY LABELED BACTERIA AND BY THYMIDINE INCORPORATION.
Limnologisch Inst., Nieuwersluis (Netherlands). Vijverhof Lab.
J. Bloem, F. M. Ellenbroek, M. J. B. Baer-Bilissen, and T. E. Cappenberg.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 7, p 1787-1795, July 1989. 7 fig, 4 tab, 33 ref.

Descriptors: *Food chains, *Aquatic productivity, *Lake stratification, *Limnology, *Fluorescence, *Lakes, *Protozoa, *Grazing, *Aquatic bacteria, *DNA, Aquatic populations, Population dynamics, The Netherlands.

In stratified Lake Vechten, The Netherlands, protozoan grazing was estimated on the basis of

uptake of fluorescently labeled bacteria and compared with bacterial production estimated on the basis of thymidine incorporation. By using a grazer-free mixed bacterial population from the lake in continuous culture, an empirical relationship between cell production and thymidine incorporation was established. Thymidine incorporation into total cold-trichloroacetic-acid-insoluble macromolecules yielded a relatively constant empirical conversion factor of ca. 10 to the 18th power bacteria/mole of thymidine at specific growth rates ranging from 0.007 to 0.116/hr. Although thymidine incorporation has been assumed to measure DNA synthesis, thymidine incorporation appeared to underestimate the independently measured bacterial synthesis by at least 1.5-fold to 13-fold, even if all incorporated label was assumed to be in DNA. However, incorporation into DNA was found to be insignificant as measured by conventional acid-base hydrolysis. This applied not only to the low-oxygen hypolimion and metalimnion but also to the aerobic epilimnion. Thus, the established empirical conversion factor for thymidine incorporation into total macromolecules was used to estimate bacterial production. Maximum production rates were found in the metalimnion and were 1 order of magnitude higher than in the epilimnion and hypolimnion. In all three strata, the estimated bacterial production was roughly balanced by the estimated protozoan grazing. Heterotrophic nanoflagellates were the major consumers of the bacterial production and showed maximum numbers in the microaerobic metalimnion. (Author's abstract)
W90-03235

TURNOVER OF EXTRACELLULAR DNA IN EUTROPHIC AND OLIGOTROPHIC FRESHWATER ENVIRONMENTS OF SOUTHWEST FLORIDA.
University of South Florida, St. Petersburg. Dept. of Marine Science.
J. H. Paul, W. H. Jeffrey, A. W. David, M. F. DeFlaun, and L. H. Cazares.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 7, p 1823-1828, July 1989. 3 fig, 3 tab, 26 ref. EPA Cooperative Agreement CR813589-02-0 and NSF Grant BSR8601570.

Descriptors: *Oligotrophy, *Springs, *Limnology, *Fate of pollutants, *Reservoirs, *Eutrophic lakes, *DNA, *Florida, Phytoplankton, Bacteria, Water chemistry, Microbiological studies, Biomass.

The turnover of extracellular DNA was investigated in oligotrophic springs of the Crystal River and the eutrophic Medard Reservoir of southwest Florida. The Medard Reservoir possessed large populations of bacterioplankton and phytoplankton (6,800 million cells per liter and 28.6 micrograms of chlorophyll a per liter, respectively), while the Crystal River springs only contained a fraction of the microbial biomass found in the Medard Reservoir. Although dissolved DNA values were greater in the Medard Reservoir, higher rates of DNA removal resulted in similar extracellular DNA turnover times in both environments (9.62 +/-3.6 hr in the Crystal River and 10.5 +/- 2.1 hr in the Medard Reservoir). These results indicate that regardless of trophic status or microbial standing stock, extracellular DNA turns over rapidly in subtropical planktonic freshwater environments. Therefore, recombinant DNA sequences from released genetically engineered microorganisms might not be expected to survive for long periods of time in freshwater planktonic environments. (Author's abstract)
W90-03236

SPATIAL AND TEMPORAL VARIATION OF WATER COLUMN MEASUREMENTS IN AQUACULTURE PONDS.
Hawaii Univ., Honolulu. Dept. of Oceanography.
For primary bibliographic entry see Field 7B.
W90-03239

EFFECTS OF NUTRIENT AVAILABILITY ON PRIMARY PRODUCTIVITY AND FISH PRO-

DUCTION IN FERTILIZED TROPICAL PONDS.
Pertanian Malaysia Univ., Serdang. Faculty of Fisheries and Marine Science.
For primary bibliographic entry see Field 8I.
W90-03240

LARGE CONCENTRATIONS OF SUBMERGED PULPWOOD LOGS AS FISH ATTRACTION STRUCTURES IN A RESERVOIR.
Maine Cooperative Fish and Wildlife Research Unit, Orono.
For primary bibliographic entry see Field 8I.
W90-03241

ABUNDANCE OF AEROMONAS HYDRO-PHILA L. AT LAKE HARNEY ON THE ST. JOHNS RIVER WITH RESPECT TO RED SORE DISEASE IN STRIPED MULLET.
University of Central Florida, Orlando. Dept. of Biological Sciences.
J. A. Osborne, G. E. Fensch, and J. F. Charba.
Florida Scientist FLSCAQ, Vol. 52, No. 3, p 171-177, Summer 1989. 1 fig, 3 tab, 13 ref.

Descriptors: *Florida, *Limnology, *Sport fishing, *Aeromonas, *Lakes, *Fish diseases, *Mullet, Aquatic bacteria, Population density, Lake sediments, Rivers, Epidemiology.

The density of Aeromonas hydrophila L. in the St. Johns river at Lake Harney, Florida was examined within the environment (water and sediment) and on striped mullet (skin and stomach) between February and August, 1982. High densities of this pathogenic bacteria occurred within the environment during midsummer when sedimentary chlorophyll a and water temperature were highest. Diseased striped mullet (fish with skin lesions), containing high densities of the bacteria within their stomachs and on their skin were more abundant during summer. This suggests that mullet, browsing on bacteria-laden sediment for algae, accumulate bacteria within their gut and on their skin which, in turn, enhances infections of red sore disease. Significant correlation coefficients were not found between Aeromonas hydrophila L. abundance (water and sediment) and dissolved oxygen, pH, total alkalinity, specific conductivity, and planktonic chlorophyll a. (Author's abstract)
W90-03242

PHOTOSYNTHESIS OF ALGAL CULTURES AND PHYTOPLANKTON FOLLOWING AN ACID PH SHOCK.
Toronto Univ. (Ontario). Div. of Life Sciences.
For primary bibliographic entry see Field 5C.
W90-03259

OXYGEN-INDUCED CHANGES IN MORPHOLOGY OF AGGREGATES OF APHANIZO-MENON FLOS-AQUAE (CYANOPHYCEAE): IMPLICATIONS FOR NITROGEN FIXATION POTENTIALS.
Michigan State Univ., Hickory Corners. W.K. Kellogg Biological Station.
For primary bibliographic entry see Field 5C.
W90-03260

UPLAND SWAMPS OF THE HIGHLAND RIM OF TENNESSEE.
Austin Peay State Univ., Clarksville, TN.
W. H. Ellis, and E. W. Chester.
Journal of the Tennessee Academy of Science JTASAG, Vol. 64, No. 3, p 97-101, July 1989. 4 fig, 15 ref.

Descriptors: *Ecosystems, *Wetlands, *Swamps, *Tennessee, *Karst, Lakes, Geology, Fens, Vegetation, Aquatic plants, Wildlife habitats, Conservation, Kentucky.

Three upland swamp communities of the Tennessee portion of the Highland Rim Section (Interior Low Plateaus Province) are described. Anderson Pond is in White County (middle-eastern, Eastern Highland Rim Subsection); Mingo Swamp is in Franklin County (southwestern, Eastern Highland

Rim Subsection); Cedar Hill Swamp is in Robertson County (Pennyroyal Plain Subsection). Anderson Pond is one of the few relatively undisturbed, permanently wet, karst ponds in the area. Cedar Hill Swamp is one of the best remaining examples of an oak swamp in the southern Pennyroyal Plain Subsection of Tennessee and Kentucky. Mingo Swamp is one of the largest undrained karst fens of its area. It contains several Coastal Plain disjuncts and apparently one new taxon (Xyris latifolia var. iridifolia). All swamps represent landforms that were once more commonplace in their respective regions and contain unique assemblages of plants. Each swamp has been evaluated and recommended as a National Natural Landmark. (Geiger-PTT)
W90-03265

FLORISTIC AND VEGETATIONAL OVERVIEW OF REELFOOT LAKE.
Tennessee Dept. of Conservation, Nashville. Div. of Ecological Services.
M. Guthrie.
Journal of the Tennessee Academy of Science JTASAG, Vol. 64, No. 3, p 113-116, July 1989. 24 ref.

Descriptors: *Reelfoot lake, *Limnology, *Lakes, *Tennessee, *Vegetation, *Aquatic plants, Submerged plants, Swamps, Marsh plants, Species diversity, Ecosystems, Bottomland.

The history of botanical exploration at Reelfoot Lake is summarized and the plant communities are briefly described and discussed. Aquatic communities include the Floating Aquatic Community, the Submerged Aquatic Community, the Emergent/Floating Aquatic Community, the Emergent Aquatic Community, the Stump or Log Community, and the Shrub Marsh Community. Bottomland hardwood communities include the Baldcypress Community, the Swamp Red Maple-Green Ash-Black Willow Community, the Sugarberry-Soft Maple-Green Ash Community, the Water Oak-Sweetgum-Bitternut Hickory Community, and the Upland Forest Community. A floristic survey of state-owned lands in 1986 yielded 400 vascular plant taxa, of which 89.5% are native. Noteworthy collections during this study are discussed because they had not been previously recorded from Reelfoot, they proved to be more common than previously believed, they are rare in the state and had not been recorded from Reelfoot for many years, or they occupy specialized or unusual habitats. These include Boltonia asteroides var. recognita, Carex comosa, Carex decomposita, Carex socialis, Crataegus mollis, Cyperus engelmannii, Hydrocotyle ranunculoides, Phacelia ranunculacea, Physalis angulata var. pendula, Polymnia laevigata, Prunus munsoniana, and Spiranthes ovalis. (Geiger-PTT)
W90-03266

AQUATIC VASCULAR FLORA AND PLANT COMMUNITIES ALONG RIVERS AND RESERVOIRS OF THE TENNESSEE RIVER SYSTEM.
Tennessee Valley Authority, Muscle Shoals, AL.
D. H. Webb, and A. L. Bates.
Journal of the Tennessee Academy of Science JTASAG, Vol. 64, No. 3, p 197-203, July 1989. 1 fig, 1 tab, 76 ref.

Descriptors: *Aquatic plants, *Species composition, *Ecosystems, *Rivers, *Lakes, *Limnology, *Reservoirs, *Tennessee River, Submerged plants, Macrophytes, Vegetation, Mosquitoes, Aquatic weeds.

Submersed vascular species and pondweeds (Potamogeton spp.) with floating leaves are listed for major rivers of the Tennessee River system. Several species, such as Podostemum ceratophyllum, are common and widespread, while others such as Potamogeton amplifolius, P. epihydrus, P. tennesseensis, and Isoetes macrospora, have restricted distributions and are considered rare. The Emory River system and the Holston River have the most diverse aquatic flora. Prior to impoundment, the lower portion of the Little Tennessee River had a diverse and widespread aquatic community that is now confined to a 2 or 3 km tailwater section of Tellico Reservoir. The Holston River, with its

luxuriant growth of aquatic macrophytes, is one of the most productive riverine environments in temperate North America. Aquatic vegetation studies conducted in reservoirs of the Tennessee River system in the 1930's and 1940's focused primarily on emergent species that provided breeding habitat for the anopheline mosquito that vectored malaria. Major changes in mainstream reservoirs have occurred during the last 30 years as a result of the introduction and naturalization of the submersed exotics Myriophyllum spicatum and Najas minor. These two species and Najas guadalupensis account for approximately 90% of the 16000 ha of aquatic plants that colonized TVA reservoirs in 1987. Hydrilla verticillata was discovered in the reservoir system in 1982 and likely will be the major submersed weed within a decade. Several emergent species, most of which are introductions or have weedy characteristics are expanding in the Tennessee River system. Several potential weeds recently have been reported from Tennessee along reservoir margins. Annual species dominate the mudflat community of mainstream reservoirs. The distribution of several species within the Tennessee Valley is primarily limited to mudflats of reservoirs. (Author's abstract)
W90-03267

AQUATIC WEED CONTROL.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
For primary bibliographic entry see Field 4A.
W90-03271

FORMS AND HYDROLYTIC BEHAVIOR OF SULPHUR IN HUMIC ACID AND RESIDUE FRACTIONS OF FOUR PEATS FROM THE FRASER LOWLAND.
British Columbia Univ., Vancouver. Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W90-03289

KINETICS OF MICROBIAL DEGRADATION OF VASCULAR PLANT MATERIAL IN TWO WETLAND ECOSYSTEMS.
Georgia Univ., Athens. Inst. of Ecology.
M. A. Moran, R. Benner, and R. E. Hodson.
Oecologia OECOBX, Vol 79, No. 2, p 158-167, May 1, 1989. 6 fig, 2 tab, 66 ref. NOAA Grant No. NA80AAD00091 and NSF Grants Nos. OCE87-18019 and BSR81-14823.

Descriptors: *Kinetics, *Microbial degradation, *Vascular tissues, *Nutrients, *Limnology, *Wetlands, *Mathematical models, *Detritus, Organic matter, Decomposition, Cycling nutrients, Ecosystems, Swamps, Marshes, Plant tissues, Biodegradation.

In shallow-water marshes and swamps, vascular plants often constitute the single most abundant source of available organic matter. Grazing by animals is minimal in typical wetland ecosystems, so that the bulk of this carbon eventually becomes part of the detritus, or non-living carbon, pool. Detritus from vascular plants is also the largest pool of photosynthate available in wetland systems. Vascular plant decomposition was followed during two different years in one freshwater and one marine wetland in southeastern Georgia, USA, using a modified litterbag technique. Chemical analysis of plant material revealed different rates of decomposition for different components of the plant material (soluble components, alpha-cellulose, hemicellulose, and lignin) and, further, that rates of decomposition of each component changed over time, such that the specific rate of decay for each fraction decreased as decomposition proceeded. Three mathematical models which differed in their treatment of the biochemical heterogeneity of vascular plant detritus were investigated with regard to their relative abilities to describe decomposition kinetics from the field incubations as well as from laboratory microcosm studies with radiolabeled plant material. A decaying coefficient model, which treats plant detritus as a single component but allows for a decreasing specific decomposition rate as material ages, was most

successful in describing kinetics of decomposition. This model accommodates the changes in quality of vascular plant detritus resulting from preferential decomposition of more labile components (for example, non-lignocellulosic material and holocellulose) and the relative accumulation of more refractory components (for example, lignin) observed with time. The model also accommodates the potential transformation of various plant components into more refractory components (humification) during the decomposition process. (Author's abstract)
W90-03344

WEST AFRICAN RIVERS AS BIOGEOGRAPHIC ISLANDS: SPECIES RICHNESS OF FISH COMMUNITIES.
Laboratoire d'Ichtyologie Generale et Appliquee, Paris (France).
B. Hugueny.
Oecologia OECOBX, Vol. 79, No. 2, p 236-243, May 1, 1989. 3 fig, 6 tab, 40 ref.

Descriptors: *Limnology, *Ecosystems, *Rivers, *Species diversity, *Fish populations, River systems, Aquatic habitats, Catchment areas, Regression analysis, Mathematical models, Ecology, Africa.

Environments surrounded by habitats unfavorable to the biological group are considered to be biogeographic islands. Because rivers are separated from each other by barriers which strictly aquatic animals cannot pass, it is justifiable to consider them as biogeographic islands. In this study, some factors influencing the species richness of West African fish communities were studied in a sample of 26 rivers using four habitat and hydrologic variables. The aim of this comparison is to test whether insularity affects species richness of West African rivers. Analysis of a larger sample of 39 rivers showed that species richness was positively related to area. A power function with exponent of 0.32 gave the best fit. As the surface area used was that of the catchment area and not that (unknown) of the river, the biological significance of this relationship and the possibilities of comparison were limited. Ridge regression analysis and forward stepwise selection indicated that a model that explained ln(species richness) as a function of ln(mean annual discharge) and ln(catchment surface area) was best, accounting for 90% of the variance of the dependent variable. The combination of surface area and discharge was presumed to act through the volume of water available for the fishes and habitat productivity. Habitat diversity, measured by the diversity of the terrestrial vegetation covering the catchment area, had no significant positive effect when surface area was used in the regression. Rivers ('islands') should have fewer species than tributaries of similar size since, for fishes within a river system ('continent'), there is free circulation between all its branches. The model derived from the river data underestimated the species richness of a sample of 11 tributaries. This was compatible with the hypothesis of higher population extinction rates in insular biotopes. The residuals of the linear model did not show random geographical distribution; the rivers in some areas had more species than expected. It is possible that historical factors, especially Quaternary climatic variations, might cause this distribution. (Author's abstract)
W90-03345

SPECIATION OF PARTICULATE TRACE METALS IN SEDIMENTS OF ANARBE RESERVOIR.
Universidad del Pais Vasco, San Sebastian (Spain). Dept. de Quimica Aplicada.
For primary bibliographic entry see Field 5A.
W90-03351

BENTHIC BACTERIAL BIOMASS AND PRODUCTION IN THE HUDSON RIVER ESTUARY.
Georgia Univ., Athens. Inst. of Ecology.
H. K. Austin, and S. E. G. Findlay.
Microbial Ecology MCBEBU, Vol. 18, No. 2, p 105-116, 1989. 6 fig, 1 tab, 43 ref. National Science

Foundation Grant BSR-8705468.

Descriptors: *Estuaries, *Rivers, *Marshes, *Hudson River, *Tidal marshes, *Bacteria, *Biomass, Cattails, Wetlands, Typha, Nuphar, Bulrushes, Benthic fauna.

Bacterial biomass, production, and turnover were determined for two freshwater marsh sites and a site in the main river channel along the tidally influenced Hudson River. The incorporation of (methyl-3H) thymidine into DNA was used to estimate the growth rate of surface and anaerobic bacteria. Bacterial production at marsh sites was similar to, and in some cases considerably higher than, production estimates reported for other aquatic wetland and marine sediment habitats. Production averaged 1.8-2.8 mg C/sq/m/hr in marsh sediments. Anaerobic bacteria in marsh sediment incorporated significant amounts of (methyl-3H)thymidine into DNA. Despite differences in dominant vegetation and tidal regime, bacterial biomass was similar in Trapa, Typha, and Nuphar aquatic macrophyte communities. Bacterial abundance and productivity were lower in sandy sediments associated with Scirpus communities along the Hudson River (200 mg c/sq m and 0.3 mg c/sq/m/hr, respectively). (Author's abstract)
W90-03370

AQUATIC HYPHOMYCETE COMMUNITIES IN CLEAR-CUT AND WOODED AREAS OF AN ILLINOIS STREAM.
Illinois Univ. at Urbana-Champaign. Dept. of Plant Biology.
For primary bibliographic entry see Field 4C.
W90-03383

FISH DISTRIBUTION IN RICHLAND CREEK, AN URBANIZING STREAM BASIN IN SOUTHWESTERN ILLINOIS.
Southern Illinois Univ. at Edwardsville. Dept. of Biological Sciences.
For primary bibliographic entry see Field 4C.
W90-03384

FISHES IN THE ILLINOIS PORTION OF THE UPPER DES PLAINES RIVER.
Southern Illinois Univ., Carbondale. Dept. of Zoology.
For primary bibliographic entry see Field 5B.
W90-03385

SURVEY OF PERSISTENT PESTICIDE RESIDUES IN THE EDIBLE TISSUES OF WILD AND POND-RAISED LOUISIANA CRAYFISH AND THEIR HABITAT.
Louisiana State Univ., Baton Rouge. Dept. of Food Science.
For primary bibliographic entry see Field 5B.
W90-03430

BIOTRANSFORMATION AND OTHER PHYSIOLOGICAL RESPONSES IN WHITEFISH CAGED IN A LAKE RECEIVING PULP AND PAPER MILL EFFLUENTS.
Kuopio Univ. (Finland). Dept. of Physiology.
For primary bibliographic entry see Field 5C.
W90-03439

GROWTH OF JUVENILE ATLANTIC SALMON, SALMO SALAR L., AND BROWN TROUT, SALMO TRUTTA L., IN A SCOTTISH RIVER SYSTEM SUBJECT TO COOLING-WATER DISCHARGE.
Freshwater Fisheries Lab., Pitlochry (Scotland).
For primary bibliographic entry see Field 5C.
W90-03448

OXYGEN-18 CONTENT OF ATMOSPHERIC OXYGEN DOES NOT AFFECT THE OXYGEN ISOTOPE RELATIONSHIP BETWEEN ENVIRONMENTAL WATER AND CELLULOSE IN A SUBMERGED AQUATIC PLANT, EGERIA DENSA PLANCH.
California Univ., Los Angeles. Dept. of Earth and

Space Sciences.
For primary bibliographic entry see Field 2I.
W90-03450

SURFACE-SEDIMENT CHRYSOPHYTES FROM 35 QUEBEC LAKES AND THEIR USEFULNESS IN RECONSTRUCTING LAKE-WATER PH.
Queen's Univ., Kingston (Ontario). Dept. of Biology.
A. S. Dixit, and S. S. Dixit.
Canadian Journal of Botany CJBOAW, Vol. 67, No. 7, p 2071-2076, July 1989. 5 fig, 1 tab, 31 ref.

Descriptors: *Bioindicators, *Acid rain effects, *Lake sediments, Sediment-water interfaces, *Chrysophyta, *Hydrogen ion concentration, Quebec, Lakes, Species composition.

Chrysophyte scales from surface sediments samples of 35 Quebec lakes were analyzed to examine their relationship with lake-water pH. The percent composition of common chrysophyte taxa were plotted against the measured lake-water pH. The distribution of many taxa was found to be closely associated with pH. The pH indicator status and abundance-weighted mean pH values of the majority of taxa of the studied region agreed with the published work. Chrysophyte counts were quantified to establish a predictive pH model using multiple regressions of pH indicator chrysophyte assemblages with lake-water pH. A strong relationship (r2 = 0.72) was observed between measured and inferred pH values. The pH predictive ability of chrysophytes was further corroborated by reconstructing the recent pH history of Lake Bonneville. Over the last 30 years, the inferred pH of this lake has declined = 1 pH unit. The present study accentuates that stratigraphic analysis of chrysophytes will provide useful measurements of the extent of lake-water acidity in Quebec. (Author's abstract)
W90-03458

MULTITROPHIC LAKE EVALUATION OF SEDIMENT TOXICITY IN WAUKEGAN AND INDIANA HARBORS.
Wright State Univ., Dayton, OH. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W90-03467

TRANSFORMATION AND EXPORT OF PHOSPHORUS FROM WETLANDS.
Ontario Ministry of the Environment, Thunder Bay (Ontario).
J. Gehrels, and G. Mulamoottil.
Hydrological Processes HYPRE3, Vol. 3, No. 4, p. 365-370, October-December 1989. 1 fig, 1 tab, 32 ref.

Descriptors: *Nutrients, *Path of pollutants, *Phosphorus, *Eutrophication, *Nutrient transport, *Wetlands, *Orthophosphates, *Sediments, Aquatic plants.

There is widespread acceptance of the phosphorus retention capability of wetlands even though research findings are often inconclusive and contradictory. The results of a one year phosphorus budget study indicate that internal wetland processes may transform sediment bound phosphorus to plant available orthophosphorus. While total phosphorus imports were nearly double the total phosphorus exports for the study wetland, orthophosphorus exports were 22% greater than imports. This study supports the recent finding that wetlands have limited capability to retain orthophosphorus and indicates that wetlands may even increase the export of orthophosphorus. The generally accepted nutrient retention function of wetlands and their possible role in eutrophication is thus questionable. (Author's abstract)
W90-03504

INCREASING DAMMING OF THE PARANA BASIN AND ITS EFFECTS ON THE LOWER REACHES.

Group 2H—Lakes

Consejo Nacional de Investigaciones Cientificas y Tecnicas, Buenos Aires (Argentina).
For primary bibliographic entry see Field 6G.
W90-03507

CHINOOK SALMON SPAWNING SURVEYS IN DEEP WATERS OF A LARGE, REGULATED RIVER.
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
G. A. Swan.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 4, p. 355-370, November-December 1989. 3 fig, 9 tab, 19 ref.

Descriptors: *Columbia River, *Spawning, *Salmon, *Deep-water habitats, *Mapping, *Data acquisition, *Fish behavior, Regulated flow, Monitoring.

In 1986 research divers surveyed and mapped deep-water spawning redds of fall chinook salmon (Oncorhynchus tshawytscha) in selected sites within an impounded segment of the main-stem Columbia River, Washington State. In velocities over 3 m/s and depths up to 11 m, two divers riding a maneuverable sled made cross-current transects communicating observations of substrate materials and deep-water spawning sites. Surface personnel tracked the position of the sled with a laser locating system that logged the information into data storage. Subsequently, the computerized data were translated into overlaying maps depicting location of redds, substrate materials, and depth contours. Deep-water spawning (>3 m) occurred at most survey sites in velocities between 0.6 and 0.8 m/s. The average depth of spawning was 6.5 m, and the maximum was 9.1 m–deeper than the depth redds can normally be detected by aerial observation (3-4 m). Deep-water spawning ranged from none to substantial in areas of near identical physical characteristics. A method for estimating abundance and density of deep-water redds, based upon the data collected with this mapping technique, is presented. This study combined with current limited information concerning deep water spawning suggests that up to 80% of the escapement of fall chinook salmon in this reach may spawn in deep water. (Author's abstract)
W90-03509

RELATIONSHIPS BETWEEN ACTINOMYCETE POPULATIONS AND ORGANIC MATTER DEGRADATION IN LAKE MULWALA, SOUTHEASTERN AUSTRALIA.
Murray-Darling Freshwater Research Centre, Albury (Australia).
P. I. Boon.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 4, p. 409-418, November-December 1989. 4 fig, 1 tab, 36 ref.

Descriptors: *Limnology, *Taste-producing algae, *Odor-producing algae, *Organoleptic properties, *Actinomyces, *Potable water, *Water quality control, *Reservoirs, Population density, Organic matter, Drinking water, Biodegradation, Lake Mulwala, Australia, Vegetation effects.

The proposal that actinomycete populations, and thus the occurrence of taste and odor problems in potable water supplies, are related to the input of organic matter to reservoirs was examined. The number of actinomycetes in Lake Mulwala, a man-made lake in southeastern Australia, ranged from 2-80/ml in the water column and 27000-120000/cu cm in the sediments. Population densities in the water column and sediments were greatest in winter and summer, respectively. They were not highly correlated with protein or polysaccharide degradation. The weak relationship between actinomycete numbers and rate of organic-matter breakdown was probably due to metabolic inactivity of the bacteria, since actinomycetes in the sediments occurred mainly as spores rather than as vegetative cells. Limiting the input of organic matter, for instance by the removal of fringing vegetation, will have little effect on actinomycete populations in this reservoir. (Author's abstract)
W90-03513

ROLE OF GAS VACUOLES AND CARBOHYDRATE CONTENT IN THE BUOYANCY AND VERTICAL DISTRIBUTION OF ANABAENA MINUTISSIMA IN LAKE ROTONGAIO, NEW ZEALAND.
Bristol Univ. (England). Dept. of Botany.
A. E. Walsby, C. S. Reynolds, R. L. Oliver, and J. Kromkamp.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 1-25, August 1989. 10 fig, 5 tab, 54 ref.

Descriptors: *Phytoplankton, *New Zealand, *Cyanophyta, *Anabaena, Lakes, *Limnology, Eutrophication, Buoyancy, Distribution, Water depth, Proteins, Carbohydrates, Diurnal distribution, Lake Rotongaio.

The late summer phytoplankton of Lake Rotongaio contained an almost pure population of Anabaena minutissima var. attenuata, a gas vacuolate species producing thin solitary filaments. The population was uniformly distributed through the top meter of the water column and then declined with depth to near zero at 6 m. The majority of the Anabaena filaments were buoyant with flotation velocities of c. 0.1 m/d. When samples of lakewater were artificially held at the surface the proportion of buoyant filaments dropped to 88.9% after 9 h of daylight, and to 44.9% at the end of the second day. Turgor pressure varied from 0.33 to 0.43 MPa and could therefore be neglected as a cause of buoyancy loss. Most of the cellular ballast could be accounted for by protein (P) and carbohydrate (C), and increases or decreases in carbohydrate ballast appeared to be the main cause of buoyancy change. A transect along the east-west axis of the lake showed an increase in C/P with distance down-wind at 0 m, and a decrease with distance upwind at 3 m. Hydrodynamic measurements on this date indicated the existence of a wind-driven circulation cell with upwelling at the western (upwind) end of the lake. A computer simulation of this population in Lake Rotongaio indicated that under completely stable conditions the Anabaena would form a maximum at 0.88 m with oscillation of +/-0.01 m over the day/night cycle. In the real lake this depth lies within the mixed layer and stratification would therefore never occur. The time scale of vertical mixing in the Lake Rotongaio was extremely short relative to that required for buoyancy control, and was considered to select in favor of positively buoyant but slowly moving filaments with an ability to exploit a low average irradiance. (Author's abstract)
W90-03514

DIEL CHANGES IN FLUORESCENCE CAPACITY, PHOTOSYNTHESIS AND MACROMOLECULAR SYNTHESIS BY ANABAENA IN RESPONSE TO NATURAL VARIATIONS IN SOLAR IRRADIANCE.
National Hydrology Research Inst., Saskatoon (Saskatchewan).
R. D. Robarts, and C. Howard-Williams.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 35-48, August 1989. 6 fig, 1 tab, 34 ref.

Descriptors: *Limnology, *Phytoplankton, *Anabaena, *Photosynthesis, Carbon fixation, Light intensity, Fluorescence, Diurnal variation, Water depth, Carbon radioisotopes, New Zealand, Polysaccharides, Solar irradiance, Lake Rotongaio.

The short-term photosynthetic responses, in terms of carbon fixation patterns and fluorescence changes, of Anabaena sp. to natural changes in the diel light cycle were measured. Anabaena was the dominant (> 95% by biomass) autotroph in eutrophic Lake Rotongaio, New Zealand during the study. Diel changes in the fluorescence capacity (FC), a relative measure of photochemical capacity, showed a marked (< 15 min) early morning rise for about 45 min followed by a sharp decline (< 5 min) as solar irradiance increased and exceeded the value of I sub k (the light intensity at which an extrapolation of the initial linear regression of the production versus irradiance curve would reach the measured light-saturated rate). This occurred at all depths to 4 m, the bottom of the mid-

day mixed layer, but did not occur beneath it. A parallel water sample incubated in a glass container to remove mixing effects showed the same diel FC response as the population above 4 m. C14 was rapidly incorporated into polysaccharide during the diurnal period, representing 55-75% of the total extracted label. As early morning light intensities approached I sub k there was a relative (%) shift from dominant nocturnal protein labelling to dominant diurnal polysaccharide labelling. Artificially exposing Anabaena to different photon fluxes demonstrated that the changes in FC and C14 incorporation were light induced responses of a shade (low I sub k) population in a dynamic, low light environment where the photoinhibition and low light responses were nearly equally important to total carbon fixation. (Author's abstract)
W90-03515

RATE OF CARBON AND NITROGEN (N2)-FIXATION WITH RESPECT TO SHORT-TERM WATER MOVEMENTS, IN LAKE ROTONGAIO (NEW ZEALAND).
Department of Scientific and Industrial Research, Taupo (New Zealand). Taupo Research Lab.
A. B. Viner.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 49-61, August 1989. 7 fig, 2 tab, 12 ref.

Descriptors: *Limnology, *Photosynthesis, *Nitrogen fixation, *Cyanophyta, *Water circulation, Lakes, Euphotic zone, Carbon radioisotopes, Water column, Vertical distribution, Carbon, New Zealand, Lake Rotongaio.

Laboratory measurements of 14C uptake and of C2H2 reduction (nitrogenase activity) were carried out on sub-surface samples from Lake Rotongaio to see whether the induced rate of change of photosynthesis and N2-fixation matched those of water movements in the lake. In the lake light was very sharply attenuated through the euphotic zone of only c 1.5 m, and the phytoplankton was photosynthetically adapted to low irradiance, but could adapt within a few hours to high irradiance. This adaptation would occur when the cyanobacteria, which dominated phytoplankton, floated to the lake surface. C2H2 reduction was sensitive to the immediate past light history of the phytoplankton. This was particularly so for the reduction rate in the dark. Reduction of C2H2 in the dark was less with increasing depth, and the gradient through the water column of C2H2 reduction in the light versus the dark could be used as an indication of relative amount of algal vertical residence time in the lake. The moderate amount of day to day variation in photosynthesis and C2H2 reduction suggests that the phytoplankton could rapidly track the changes in environment brought by the hydrodynamic events in the lake. (Author's abstract)
W90-03516

COEXISTENCE AND EXCLUSION OF ZOOPLANKTON BY ANABAENA MINUTISSIMA VAR. ATTENUATA IN LAKE ROTONGAIO.
Otago Univ., Dunedin (New Zealand). Dept. of Zoology.
C. W. Burns, J. Forsyth, J. F. Haney, M. R. James, and W. Lampert.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 63-82, August 1989. 6 fig, 5 tab, 34 ref.

Descriptors: *Cyanophyta, *Zooplankton, *Anabaena, *Eutrophication, *Limnology, *Daphnia, New Zealand, Feeding, Filter feeders, Growth, Lake Rotongaio.

The effects on Boeckella propinqua, Ceriodaphnia dubia, Bosmina meridionalis and Daphnia carinata of a dense bloom of Anabaena minutissima var. attenuata in Lake Rotongaio were examined by measuring filtering and feeding rates, direct observations and in situ enclosures. High densities of Anabaena had a negative effect on the feeding behavior of the cladoceran grazers, Daphnia and Ceriodaphnia, through mechanical interference with the filtering mechanism, selection against An-

abaena, and inhibitory substances in solution. The effect on Daphnia was particularly detrimental. The resident zooplankton were able to maintain themselves at this time through a variety of mechanisms including vertical displacement, small size, selective feeding and utilization of Anabaena. (Author's abstract)
W90-03517

PHYTOPLANKTONIC MONOTONY I. LOW SPATIAL HETEROGENEITY FOR NITROGEN FIXATION, ALGAE, NUTRIENTS, AND TEMPERATURE, BUT NOT FOR ZOOPLANKTON, IN LAKE ROTONGAIO, NEW ZEALAND.
California Univ., Berkeley. Dept. of Civil Engineering.
A. J. Horne, and M. L. Commins.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 83-97, August 1989. 5 fig, 3 tab, 42 ref.

Descriptors: *New Zealand, *Phytoplankton, *Cyanophyta, *Anabaena, *Limnology, *Zooplankton, Chemical properties, Nitrogen, Phosphorus, Spatial heterogeneity, Lloyds index, Lake Rotongaio.

The autumn phytoplankton of Lake Rotongaio in 1987 was dominated by a dense stand of single filaments of Anabaena minutissima var. attenuata. Instantaneous spatial heterogeneity for 18 primary variables was measured by synoptic sampling of 30 stations on a 100 m grid. The lake surface water had a regular distribution pattern of seven variables: temperature, PO4, dissolved organic P, NO3, N:P, nitrogenase activity, and number of rotifer taxa. Three other variables: particulate, P, NH4, and dissolved organic N, showed a random distribution. The remaining eight variables were patchy (ratio of variance: mean significantly > 1). Of these, the five phytoplankton features (heterocysts, Anabaena filaments, chlorophyll, photosynthesis, and particulate N) were only slightly patchy. Patchiness is often described using Lloyds index, derived from the variance: mean ratio. A high index shows high spatial heterogeneity. The Lloyd's indices for the five slightly patchy variables in Rotongaio (1.01 to 1.13) were lower than results from other lakes at similar wind speeds. In contrast, the three common taxa of surface zooplankton were highly patchy, varying in abundance by factors of 9 to 12. The Lloyd's indices for zooplankton were the highest found in Rotongaio (.127 to 1.96) and were similar to those in other lakes. Nitrogen fixation was regularly distributed at both 100 m and 1 m scales of resolution while chlorophyll and zooplankton were patchy at 100 m but randomly distributed at 1 m. The paradox of a monotonous distribution of most variables at low wind speeds was likely due to a combination of a shallow thermocline (which allows less wind and evaporation to mix the epilimnion more thoroughly) and small algal filaments which are less buoyant than large colonies). Thus even light winds (1-2 m/s) eroded patches of phytoplankton but not zooplankton. (See also W90-03519) (Author's abstract)
W90-03518

PHYTOPLANKTON MONOTONY II. PATTERNS OF TEMPORAL STABILITY IN PHYTOPLANKTON PATCHES IN LAKE ROTONGAIO, NEW ZEALAND.
California Univ., Berkeley. Dept. of Civil Engineering.
A. J. Horne, and M. L. Commins.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 99-112, August 1989. 5 fig, 2 tab, 24 ref.

Descriptors: *Phytoplankton, *Cyanophyta, *New Zealand, *Anabaena, *Limnology, *Nitrogen fixation, Lake Rotongaio, Temporal stability, Ecology, Distribution, Correlation analysis, Buoyancy.

The temporal stability of patches of a unialgal bloom of the cyanobacterium Anabaena minutissima var. attenuata was estimated from the strength of the correlation between nitrogenase activity and 17 biochemical, chemical and physical parameters measured almost simultaneously at 30 stations in Lake Rotongaio, New Zealand. On a

lake-wide basis, nitrogenase activity was not highly correlated with temperature, nutrients (r sub 2 = 0.001-0.29, including nitrate), or zooplankton (r sub 2 = 0.04-0.28). Variation in nitrogen activity was better explained by a multiple regression of all variables (R sub 2 = 0.81, 0.72 corrected) but no single variable dominated on a lake-wide basis. Even Anabaena-related components (heterocysts, particulate N or P, chlorophyll a, number of filaments, and photosynthesis) were less well correlated with nitrogenase (r sub 2 = 0.31-0.62) than in other lakes. Because of the low correlations, most temporary patches were deduced to be short-lived (< 1 day). The temporal instability of surface patches was attributed to algal sinking. The algae became less buoyant due to production of carbohydrate ballast and sand thus destroying patchiness and correlations with soluble nutrients. The algae were then carried back across the lake at the nutrient-rich thermocline. Changes in light and nutrients are inherent in this 'switching conveyor belt' phytoplankton movement model. Two exceptions (stable patches) were found. First, in the western third of the lake nitrogenase activity showed a strong negative correlation with nitrate (r = 2 0.65). This zone was influenced by upwelling. Second, there was a patch with chlorophyll concentrations which were significantly higher than those in the rest of the lake. This patch overlapped a larger area of unhealthy algae (low ratios of growth to chlorophyll) in the lake center. The algae in these patches may have been unable to photosynthesis sufficient carbohydrate ballast to sink and either oscillated back and forth with the diel reversal of the wind or were permanently trapped in a topographically-induced eddy. (See also W90-03518) (Author's abstract)
W90-03519

CYANOBACTERIA VS. DIATOMS: MECHANISMS LIMITING THE SPATIAL AND TEMPORAL PATTERNS OF NITROGEN, PHOSPHORUS AND CHLOROPHYLL IN LAKE ROTONGAIO (NEW ZEALAND).
Department of Scientific and Industrial Research, Taupo (New Zealand). Taupo Research Lab.
A. B. Viner.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 113-135, August 1989. 9 fig, 7 tab, 22 ref.

Descriptors: *Limnology, *Phytoplankton, *Cyanophyta, *Diatoms, *New Zealand, *Cycling nutrients, Nitrogen, Phosphorus, Seasonal variation, Lake Rotongaio, Chlorophyll, Nutrient sources.

Horizontal, vertical and temporal distributions of the particulate and dissolved forms of nitrogen and phosphorus and of chlorophyll were investigated in the Lake Rotongaio (North Island, New Zealand) between September 1979 and January 1981. The importance of inflow N and P was small compared with the lake's internal loading. Particulate P and chlorophyll showed a small winter maximum which was due to diatom growth, but which was masked for the particulate N because the N content of the cyanobacteria, dominant in spring-summer, was raised due to their N2-fixation. Very large fluctuations of particulate material over 2-3 weeks during cyanobacterial dominance, but not diatom dominance, was caused by alternating flushing out of surface water by wind and subsequent rapid growth, the process being strongly influenced by the upward floating of the cyanobacteria into the flushed zone. This sequence of events, which characterizes the lake, provides a mechanism against potentially catastrophic cyanobacterial growth. Diatoms were probably limited in late winter by available light. The large seasonal changes in total N and P through the water column were dominated by hypolimnetic release of NH4-N and dissolved reactive phosphorus (DRP). Rapid mineralization of detritus from the epilimnion to produce these components as well as dissolved organic nitrogen and dissolved organic phosphorus indicated that autochthonous N and P supplies dominated the lake's metabolism. But estimated rates of change of NO3-N suggested that nitrification and denitrification were not important relative to ammonification. The large amount of organic material present apparently saturated any sorption effects on DRP concentration. Autochth-

onous processes are so great as to largely insulate the lake's features from outside influences. (Author's abstract)
W90-03520

PHYTOPLANKTON SUCCESSION AND CYANOBACTERIAL DOMINANCE IN A EUTROPHIC LAKE OF THE MID-TEMPERATE ZONE (LAKE OKARO, NEW ZEALAND).
Department of Scientific and Industrial Research, Taupo (New Zealand). Taupo Research Lab.
W. F. Vincent, and S. J. Dryden.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 137-163, August 1989. 14 fig, 2 tab, 29 ref.

Descriptors: *New Zealand, *Phytoplankton, *Diatoms, *Cyanophyta, *Limnology, *Eutrophic lakes, *Dinoflagellates, *Chlorophyta, Eutrophication, Succession, Seasonal variation, Lake Okaro.

Phytoplankton succession in Lake Okaro, a small eutrophic lake with a mild, mid-latitude (38 degrees S) climate, was distinguished by a continuous change in community structure throughout the year. There was a sequence of diatom populations from autumn (March) to spring (September): Synedra ulna (peak Asterionella formosa (August-September) and Cyclotella stelligera (September). Many other species were superimposed upon this diatom succession, including Ceratium hirundinella which steadily rose from autumn to spring, and Cryptomonas erosa, Staurastrum spp. and Closterium aciculare which all occurred throughout winter in high concentrations. Cyanobacteria were among the phytoplankton dominants in summer, but the species Microcystis aeruginosa persisted into winter isothermy, and a population of Anabaena spiroides began to grow in late winter when lakewater temperatures had dropped to the annual minimum (8 degrees C). Principal components analysis of the succession showed an elliptical progression throughout the year that correlated with temperature and underscored the continuous, deterministic cycle of species change. Although irregular, short-term (1-3 weeks) fluctuations in cell count were recorded for many species, most of the phytoplankton dominants achieved their large population size by maintaining slow but persistent net growth rates over long periods of time, e.g. Ceratium hirundinella at 0.05 per day over 9 weeks, Coelastrum microporun at 0.07 per day over 21 weeks, Melosira granulata at 0.07 per day over 16 weeks and Anabaena spiroides at 0.06 per day over 13 weeks. Microcystis aeruginosa rose to its high cell concentrations more rapidly (0.24 per day over four weeks), but then held its population to within an order of magnitude maintained by slow persistent growth under a wide variety of environmental regimes rather than by rapid accelerated responses to brief episodes of optimal conditions. (Author's abstract)
W90-03521

COMMUNITY RESPONSES OF THE LATE SUMMER PHYTOPLANKTON OF LAKE OKARO (NEW ZEALAND) TO EXPERIMENTAL CHANGES IN NUTRIENT ABUNDANCE: EVIDENCE OF NITROGEN LIMITATION IN THE PRESENCE OF PHOSPHORUS DEFICIENCY.
Department of Scientific and Industrial Research, Taupo (New Zealand). Taupo Research Lab.
E. White, M. T. Downes, G. W. Payne, S. Pickmere, and P. Woods.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 165-175, August 1989. 2 fig, 8 tab, 19 ref.

Descriptors: *New Zealand, *Phytoplankton, *Nutrients, *Bioassay, *Limnology, *Eutrophic lakes, Cyanophyta, Dinoflagellates, Nitrates, Phosphates, Chlorophyll a, Redfield ratio, Seston, Microcystis, Paulschulzia, Ceratium, Peridinium.

The late summer phytoplankton community of eutrophic Lake Okaro was subjected to nutrient manipulation in enclosures over a period of 10 days. Algae contributing significantly to initial biomass were Microcystis, Paulschulzia, Ceratium and Per-

idinium. The community exhibited evidence of extreme phosphorus deficiency at the start of the experiment. Addition of iron had little effect on the biomass indicators, chlorophyll a, particulate carbon and particulate nitrogen. Similarly, addition of phosphate alone had no effect on biomass. By contrast, addition of nitrate alone produced increases in all biomass indicators. These increases were not as great as those achieved when nitrate and phosphate were added together. In spite of the initial phosphorus deficiency exhibited by this algal community its biomass was controlled by a shortage of nutrient nitrogen. The elemental ratios of the particulate material were initially in excess of the Redfield ratio, a feature which persisted throughout the experiment in the control enclosures. When nitrate was added alone, the elemental ratios diverged further from the Redfield ratios. However, on addition of phosphate alone, elemental ratios decreased to approximate those of Redfield although no growth occurred. Low ratios also developed in those enclosures where growth was stimulated by the addition of both phosphate and nitrate. That ratios approximating those of Redfield can occur in algae of two quite different nutritional states may impact adversely on recent hypotheses which suggest that algal growth in oceans is rarely controlled by a shortage of nutrients. (Author's abstract)
W90-03522

SPECIES-SPECIFIC PHYTOPLANKTON RESPONSES TO NUTRIENT ENRICHMENT IN LIMNETIC ENCLOSURES.
Ottawa Univ. (Ontario). Dept. of Biology.
F. R. Pick.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 177-187, August 1989. 4 fig, 2 tab, 24 ref.

Descriptors: *Phytoplankton, *Limiting nutrients, *Chlorophyta, *Eutrophication, *Limnology, *Eutrophic lakes, *Cyanophyta, *Dinoflagellates, Nitrogen, Phosphorus, Iron, Species composition, Biomass, New Zealand, Lake Okaro.

Enclosure experiments in Lake Okaro, New Zealand, were performed to determine the effects of macronutrient supply ratios on phytoplankton community structure. When phosphorus additions were used to shift the ambient total nitrogen (TN) to total phosphorus (TP) ratio from 10 to 5 (by weight), total phytoplankton biomass declined and was not significantly different from the control values at the end of the experiment. Community composition was not altered despite a small reduction in the dominant green alga Paulschulzia pseudovolvox. With nitrogen additions, total algal biomass increased because of increased green algal biomass (P. pseudovolvox, Staurastrum) and the relative proportion of this taxonomic group increased significantly. These green algae also increased in the combined nitrogen and phosphorus treatments (TN/TP = 10), along with significant increases in Microcystis aeruginosa, Peridinium palustre and various microflagellates. By day ten, the percent cyanobacterial biomass (composed entirely of M. aeruginosa) was significantly higher under the N + P treatment (59 +/-6%) and only slightly lower under the + N treatment (23 +/-7%) relative to the control (33+/-7%). Iron additions did not alter biomass or community composition. (Author's abstract)
W90-03523

RESPONSES OF THE ZOOPLANKTON TO NUTRIENT ENRICHMENT OF LARGE ENCLOSURES IN LAKE OKARO, NEW ZEALAND.
Otago Univ., Dunedin (New Zealand). Dept. of Zoology.
S. F. Mitchell.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 189-193, August 1989. 1 tab, 18 ref.

Descriptors: *Eutrophic lakes, *Eutrophication, *Limnology, *New Zealand, *Zooplankton, *Phytoplankton, *Nutrients, Nitrogen, Phosphorus, Crustaceans, Life cycles, Cyanophyta, Chlorophyta, Lake Okaro.

All three of the major taxa among the macrozooplankton in Lake Okaro showed evidence of inhibition in response to increase in the phytoplankton produced by nutrient enrichment of replicated 1 cu m enclosures over 10 days in situ. Phytoplankton showed essentially two levels of response in relation to the controls--one to the addition of inorganic nitrogen and another, greater response in relation to phosphorus. At the highest phytoplankton level, numbers of Bosmina (Neobosmina) meridionalis, Asplanchna, and nauplii of Calamoecia lucasi were all significantly lower than in the controls. Egg production in Calamoecia was suppressed at even the lower phytoplankton response, which involved significant increases in Chlorophyceae but none in the Cyanophyceae. (Author's abstract)
W90-03524

LAKE OKARO ENCLOSURE EXPERIMENTS: TEST ECOSYSTEMS TO EVALUATE PLANKTON PHOSPHORUS AND NITROGEN DEFICIENCY.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
D. R. S. Lean, F. R. Picks, S. F. Mitchell, M. T. Downes, and P. H. Woods.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 195-211, August 1989. 6 fig, 3 tab, 42 ref.

Descriptors: *New Zealand, *Phytoplankton, *Limiting nutrients, *Bioassay, *Eutrophication, *Eutrophic lakes, *Limnology, Phosphorus, Nitrogen, Carbon, Carbon radioisotopes, Growth, Algal physiology.

Physiological indicators for nutrient deficiency were evaluated against the phytoplankton growth response to phosphate and nitrate additions to enclosures in Lake Okaro, New Zealand. At the start of the experiment, phosphate turnover time and the ratio of 14C-bicarbonate assimilation at optimal light to the maximum uptake velocity for phosphate indicated that the plankton were P-deficient. However, over the next 10 days, the biomass declined with phosphate enrichment but was stimulated with nitrate enrichment. When these two nutrients were added together, the biomass increase was greater than with nitrate alone and continued to increase for the entire period. Ratios of particulate C, N and P were of little use in predicting the growth limiting nutrients. The uptake rates of phosphate, ammonium and nitrate normalized/unit particulate P or N was compared to that for 14C-bicarbonate assimilation/unit C. These data illustrated the remarkable P-storage capacity and the relatively poor N-storage capacity of phytoplankton. N uptake expressed as a percent of particulate N was similar to carbon assimilation expressed as a percent of particulate C. The ratio of 14C-bicarbonate assimilation to the maximum uptake velocity for ammonium or nitrate indicated which enclosures were most N-deficient but with the limited N-storage capacity, the range between N-sufficient and N-deficient was small. Bioassays which involve ratios of the maximal uptake ratio of phosphate to ammonium or nitrate are biased toward P-uptake and can fail to provide information on growth limitation. Only the bioassay which depends on enhanced dark carbon assimilation with ammonium enrichment correctly predicted that the plankton was limited by nitrogen. All bioassays which involve estimates of uptake rates reflect the nutrient storage depletion relative to maximal cell quota. Because algae can store large amounts of phosphorus, large uptake rates for this nutrient can occur while growth may be limited by nitrogen shortage. (Author's abstract)
W90-03525

CRITICAL EVALUATION OF THE DARK AMMONIUM ENHANCEMENT BIOASSAY FOR NITROGEN DEFICIENCY IN PHYTOPLANKTON.
Otago Univ., Dunedin (New Zealand). Dept. of Zoology.
S. F. Mitchell.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 213-219, August 1989. 1 fig, 1 tab, 17 ref.

Descriptors: *Phytoplankton, *Nitrogen, *Bioassay, Carbon radioisotopes, Chlorophylla, New Zealand, Nitrogen limitation.

The assay for nitrogen deficiency in phytoplankton which relies on enhancement of rates of dark 14CO2 fixation by nitrogen deficient algae in response to additions of ammonium ions is reviewed. Previous authors have expressed results as the ratio of dark CO2 fixation in the experimental bottles to that in the controls. It is shown that results are better expressed as chlorophyll-specific increases in dark CO2 fixation in response to experimental treatment. Studies on several North Island New Zealand lakes and recalculated published data for some other lakes suggest that nitrogen-deficient algae are characterized by enhancement rates > 0.02 mg C/mg chlorophyll a/h, and nitrogen-sufficient cells by rates of 0.007 mg C/mg Chlorophyll a/h or less. (Author's abstract)
W90-03526

BUOYANCY AND VERTICAL DISTRIBUTION OF ANABAENA SPIROIDES IN LAKE OKARO (NEW ZEALAND).
Department of Scientific and Industrial Research, Taupo (New Zealand). Taupo Research Lab.
A. B. Viner.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 221-238, August 1989. 9 fig, 5 tab, 38 ref.

Descriptors: *Phytoplankton, *Cyanophyta, *Anabaena, *New Zealand, *Limnology, *Eutrophication, *Eutrophic lakes, Buoyancy, Lake Okaro, Distribution, Carbohydrates, Photosynthesis, Biomass, Light limitation.

During the spring and summer of 1987 Anabaena spiroides Kleb attained an almost monospecific dominance in Lake Okaro (North Island, New Zealand). The lake was sampled approximately weekly to study this species vertical distribution in terms of its buoyancy control. Gas vesicle characteristics (giving positive buoyancy) and carbohydrate content (giving negative buoyancy) were experimentally manipulated in the laboratory. Little net growth occurred in the water column but vertical changes in concentration did occur which were interpreted as due to adjustments in cellular carbohydrate content, and therefore to the degree of exposure to light for photosynthesis. There was no evidence of buoyancy control by changes in the amount of gas vesicles/cell. Ecologically the lake was stabilized by the extreme light attenuation afforded by the large Anabaena biomass being able to keep buoyant and viable within and well below the euphotic zone. It thus precluded potential competing species by light limitation. Once established this stability would probably need major physical perturbation to change it. (Author's abstract)
W90-03527

CYANOBACTERIAL GROWTH AND DOMINANCE IN TWO EUTROPHIC LAKES: REVIEW AND SYNTHESIS.
Department of Scientific and Industrial Research, Taupo (New Zealand). Taupo Research Lab.
W. F. Vincent.
Archiv fuer Hydrobiologie. Ergebnisse der Limnologie. Vol. 32, p 239-254, August 1989. 4 fig, 1 tab, 22 ref.

Descriptors: *Phytoplankton, *New Zealand, *Cyanophyta, *Eutrophic lakes, *Eutrophication, *Limnology, Biomass, Anabaena, Microcystis, Diversity, Population dynamics, Buoyancy, Zooplankton, Succession, Nutrients.

A multidisciplinary program of environmental observations and experiments was conducted on two eutrophic lakes of similar area, depth and climate to evaluate possible causes of their strikingly different phytoplankton composition. During the late summer study period Lake Rotongaio contained a large population (140 microg Chl a/L) of Anabaena minutissima var. attenuata, while Lake Okaro contained a smaller (11 microg Chl a/L) and more diverse phytoplankton assemblage com-

posed of green algae, dinoflagellates and Microcystis aeruginosa. The variably buoyant colonies of Microcystis were capable of optimizing their position in the 4-6 m deep mixed layer by rapidly sinking or floating. The large biomass of dispersed Anabaena filaments in Lake Rotongaio substantially reduced the water transparency and caused near-surface solar heating, which in turn restricted the mixed-layer to 1-3 m depth under light to moderate winds. The Rotongaio population showed considerable diel and day-to-day variations in its photosynthesis versus irradiance parameters suggesting that the cyanobacteria were metabolically attuned to short-term (hours) changes in their environment. A 10-day replicated enclosure experiment at Lake Okaro elicited no response to + P enrichment but there was a pronounced stimulation of green algal growth by + N enrichment, and a shift towards dominance by Microcystis aeruginosa when N and P were added in combination. The large population of Anabaena in Lake Rotongaio suppressed zooplankton grazing by chemical and mechanical effects. From the combined series of measurements on Lake Okaro and Lake Rotongaio it is concluded that the observed differences in phytoplankton community structure in summer were initiated by differences in the chemical environment of the two lakes, but were amplified by a variety of feedback effects. (Author's abstract)
W90-03528

FORMATION OF SUB-SURFACE MAXIMA OF A DIATOM WITHIN A STRATIFIED LAKE AND IN A LABORATORY COLUMN.
Freshwater Biological Association, Ambleside (England).
S. I. Heaney, M. C. Davey, and A. S. Brooks.
Journal of Plankton Research JPLRD9, Vol. 11, No. 6, p 1169-1184, November 1989. 6 fig, 40 ref.

Descriptors: *Diatoms, *Lake stratification, *Primary productivity, *Limnology, Seasonal variation, Asterionella, Silicon, Buoyancy, Chemical composition, Population studies.

The development of a sub-surface layer of the diatom Asterionella formosa Hass. was studied during the final phase of its spring growth and subsequent decline in a moderately productive, 60 m deep lake. The layer was short-lived (about 2 weeks), had a maximum cell concentration four times greater than in the waters above and below, and formed within the pycnocline at the silicon gradient and the base of the euphotic zone. The mechanisms governing the formation of sub-surface maxima were examined in a 4 m tall stratified laboratory column using live and formaldehyde-killed cultures of A. formosa. Dead cells added to the top of the column formed a broad layer as they sedimented through the density gradient. This was in contrast to a more discrete maximum with a sharp lower boundary obtained using silicon-depleted cells as they encountered a silicacline within the pycnocline. There were marked changes in the chemical composition of live cells during the phase of growth and settlement in the experimental column. Silicon-depleted cells entering the deep silicacline showed a decrease in sinking rate within a period of 1 day. It is clear from the laboratory experiments that changes in the biological characteristics of the population, in particular its sinking velocity, are required for the formation of mid-water maxima of the form observed in natural populations. These changes intensify accumulations of settling cells within vertical density gradients. (Author's abstract)
W90-03532

CONTROL OF SUB-SURFACE MAXIMA OF DIATOMS IN A STRATIFIED LAKE BY PHYSICAL, CHEMICAL AND BIOLOGICAL FACTORS.
Freshwater Biological Association, Ambleside (England).
M. C. Davey, and S. I. Heaney.
Journal of Plankton Research JPLRD9, Vol. 11, No. 6, p 1185-1199, November 1989. 4 fig, 2 tab, 33 ref.

Descriptors: *Limnology, *Diatoms, *Silicon, *Lake stratification, *Phytoplankton, Buoyancy,

Water depth, Sedimentation, Nutrients, Thermal stratification.

The sedimentation patterns of Asterionella formosa Hass. were observed in two lake basins, in one of which a mid-water population maximum of the diatom occurred. Comparison of the alga's distribution with vertical profiles of temperature and dissolved reactive silicon suggested that the formation of a mid-water maximum was associated with a sharp silicon gradient. Sinking velocities of the diatom were reduced at the maximum compared to those at lesser or greater depths. The suspension of cultures at different depths, in either nutrient-replete medium or exposed to the prevailing nutrient conditions, following thermal stratification, confirmed that an increase of sinking velocity occurred in silicon-deficient or light-deficient populations. It is suggested that the mid-water maximum of A. formosa was formed by differential colony sinking velocities with depth in response to variations in silicon availability. The formation of a strong silicon gradient was dependent upon the growth of the population being restricted to the epilimnion by the onset of thermal stratification. (Author's abstract)
W90-03533

PHYTOPLANKTON STUDIES IN THE FJORDS OF WEST SPITZBERGEN: PHYSICAL ENVIRONMENT AND PRODUCTION IN SPRING AND SUMMER.
Tromsoe Univ. (Norway). Inst. of Fisheries.
For primary bibliographic entry see Field 2L.
W90-03535

NATURAL DEVELOPMENT TIME OF EODIAPTOMUS JAPONICUS (COPEPODA: CALANOIDA) IN LAKE BIWA.
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
K. Kawabata.
Journal of Plankton Research JPLRD9, Vol. 11, No. 6, p 1261-1272, November 1989. 1 fig, 10 tab, 24 ref.

Descriptors: *Limnology, *Copepods, *Japan, *Life history studies, Juvenile growth stage, Foods, Temperature, Seasonal variation, Mortality, Eodiaptomus.

Seasonal and ontogenetic changes in natural development time were studied for Eodiaptomus japonicus in Lake Biwa in 1986 and 1987. Wild individuals in a certain developmental stage were collected, fed on natural food and examined until they had molted twice. Natural development times fluctuated irrespective of temperature from May to October. Food deficiency delayed development in all feeding stages, and food availability probably determined natural development time. Serious food limitation raised mortality in copepodid stage I. In November development was delayed even with enough food. The development of E. japonicus was almost isochronal except for a short prefeeding naupliar stage I and a long copepodid stage V. (Author's abstract)
W90-03536

SEASONAL SUCCESSION IN THE PLANKTON OF A NATURALLY ACIDIC, HIGHLY HUMIC LAKE IN NORTHEASTERN OHIO, USA.
Kent State Univ., OH. Dept. of Biological Sciences.
K. E. Havens.
Journal of Plankton Research JPLRD9, Vol. 11, No. 6, p 1321-1327 November 1989. 6 fig, 18 ref.

Descriptors: *Wetlands, *Limnology, *Acid lakes, *Plankton, *Bogs, *Ohio, Phytoplankton, Zooplankton, Predation, Species diversity, Hydrogen ion concentration, Rotifers, Seasonal variation.

A 13 month study of the plankton in a naturally acidic bog lake in Portage County, Ohio showed high algal biovolume, year-round dominance by flagellates and mid-summer dominance by Gonyostomum semen. Zooplankton abundance and species richness was very low. Rotifers were the year-

round dominants. The absence of cladocerans may be due in part to selective removal by invertebrate predators, as all of the summer dominants had effective anti-predator devices. The low zooplankton species richness in the lake and the absence of large cladocerans such as Daphnia are probably consequences of toxic effects of H+ on acid-sensitive species. (Author's abstract)
W90-03537

2I. Water In Plants

RESPONSE OF THREE MANGROVES TO SALINITY IN TWO GEOFORMS.
Instituto de Ecologia, A.C., Mexico City.
For primary bibliographic entry see Field 2L.
W90-02661

MACRO- AND MICROALGAL PRODUCTION WITHIN A NITELLA OPACA BED IN LAKE THINGVALLAVATN, ICELAND.
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
For primary bibliographic entry see Field 2H.
W90-02669

ABOVE-GROUND NUTRIENT TURNOVER AND NET PRIMARY PRODUCTION OF AN EVERGREEN AND A DECIDUOUS SPECIES IN A HEATHLAND ECOSYSTEM.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.
For primary bibliographic entry see Field 2H.
W90-02670

DIEL PATTERNS OF ZOOPLANKTON GRAZING IN A SHALLOW LAKE.
Ecole Normale Superieure, Paris (France). Lab. d'Ecologie.
For primary bibliographic entry see Field 2H.
W90-02676

ULTRASTRUCTURAL RESEARCH ON NATURAL POPULATIONS OF PICOPLANKTON FROM TWO BRACKISH WATER ENVIRONMENTS IN ITALY.
Padua Univ. (Italy). Dept. of Biology.
C. Andreoli, N. Rascio, F. Dalla Vecchia, and L. Talarico.
Journal of Plankton Research, Vol. 11, No. 5, p 1067-1074, September 1989. 19 fig, 25 ref.

Descriptors: *Plankton, *Cyanophyta, *Brackish water, Algae, Chrysophyta, Chlorella, Nitzschia, Microbiological studies.

The picoplankton populations from two brackish water environments showed abundances of both cyanobacteria and eukaryotic microalgae. The sites investigated were the Valle Pozzatini (near the Po River deta) where some ponds have been built for fish breeding) and S. Gilla, a lagoon in Sardinia used for experimental cultivers of Tapes semidecussatus. Both fluorescence light and electron microscopy were used to identify the plankton. Among the cyanobacteria, most forms belonged to Chroococcales. Eukaryotic microalgae were represented by species belonging to Chlorophyceae (Chlorella), Bacillariophyceae (Nitzschia) and Chrysophytes. (Author's abstract)
W90-02678

SEASONAL EFFECTS OF FLOODING ON GREENHOUSE-GROWN SEEDLING PECAN TREES.
Oklahoma State Univ., Stillwater. Dept. of Horticulture and Landscape Architecture.
M. W. Smith, and R. D. Bourne.
Hortscience HJHSAR, Vol. 24, No. 1, p 81-83, Feb 1989. 2 tab. 10 ref.

Descriptors: *Flood damage, *Floods, *Plant growth, *Plant physiology, Nuts, Plant morphology, Chemical composition.

Group 2I—Water In Plants

Seedling pecan tree (Carya illinoensis (Wangenh) C. Koch) roots were flooded for 28 days while trees were either dormant, beginning budbreak, or in active growth, plus an unflooded control. Flooding roots while trees were dormant did not affect growth and seldom affected leaf elemental concentrations compared to unflooded trees. Trees with roots flooded during budbreak usually had less leaf area and were shorter, with smaller trunks than unflooded trees. Leaf N and Fe concentrations were decreased immediately after flooding, but 56 days after trees were drained, P, Ca, Mg, Zn, and Mn concentrations were greater than in unflooded trees. Leaf area, tree height, trunk diameter, and leaf and trunk dry weights were not affected by flooding during active growth. Root dry weight was reduced 31% immediately after trees were drained, and 48% 56 days after trees were drained compared to unflooded trees. Trees flooded during active growth had lower concentrations of N, P, K, Ca, Mg, Zn, Fe, and Mn immediately after flooding, but 56 days after trees were drained, leaf elemental concentrations were not significantly different from unflooded trees. (Author's abstract)
W90-02743

MODEL OF TRANSPIRATION AND SOIL-WATER BALANCE FOR A MATURE OAK FOREST.
Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Paris (France).
For primary bibliographic entry see Field 2D.
W90-02779

MODELING THE EFFECTS OF AMAZONIAN DEFORESTATION ON REGIONAL SURFACE CLIMATE: A REVIEW.
National Center for Atmospheric Research, Boulder, CO.
For primary bibliographic entry see Field 4C.
W90-02783

CHANGES IN THE COMPOSITION OF RAINWATER UPON PASSAGE THROUGH THE CANOPIES OF TREES AND OF GROUND VEGETATION IN A DUTCH OAK-BIRCH FOREST.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Geology.
For primary bibliographic entry see Field 5B.
W90-02826

IRRIGATION EFFECTS ON WATER USE, AND PRODUCTION OF TAP ROOTS AND STARCH OF BUFFALO GOURD.
Maricopa Agricultural Center, AZ. Dept. of Plant Science.
For primary bibliographic entry see Field 3F.
W90-02829

DETRIMENTAL INTERACTION OF SUBSOIL ALUMINUM AND DROUGHT STRESS ON THE LEAF WATER STATUS OF SOYBEAN.
Wisconsin Univ.-Madison. Dept. of Agronomy.
For primary bibliographic entry see Field 3F.
W90-02830

MULCH AND IRRIGATION PLACEMENT EFFECTS OF SOIL CHEMISTRY PROPERTIES AND RABBITEYE BLUEBERRY PLANTS IRRIGATED WITH SODIC WATER.
Agricultural Research and Extension Center, Overton, TX.
For primary bibliographic entry see Field 3C.
W90-03229

DROUGHT RESISTANCE IN PLANTS.
Texas A and M Univ., El Paso. Agricultural Research and Extension Center.
J. L. Tipton.
Grounds Maintenance, Vol. 23, No. 8, p 14-16, 20-22, August 1988. 1 ref.

Descriptors: *Plant physiology, *Water use efficiency, *Drought resistance, Water deficit, Drought, Roots, Moisture deficiency, Dehydration, Water loss, Survival, Leaves, Photosynthesis.

In order to save water, water-efficient plants and drought-resistant plants should not be mixed in a dry location. Drought resistance is a plant's ability to survive extended periods of drought in a relatively active state. Plants with high drought resistance are not usually efficient users of water. Drought resistance is the product of avoidance and tolerance. Drought avoidance refers to those mechanisms that allow a plant to avoid drought by either increasing water uptake or restricting water loss. Drought tolerance refers to those mechanisms that allow a plant to tolerate dehydration. Some water-saving mechanisms used by drought avoiders include frequent stomatal closure, low cuticular transpiration, reduced leaf surface, and photosynthetic adaptations. Some drought avoiders have adaptations that permit a high rate of water absorption. These mechanisms include a high ratio of conducting to nonconducting tissue, a high root:shoot ratio, efficient water-absorbing potential, ability to absorb dew, and the ability to become a water-saver when severe drought hits. Drought-resistant plants must possess both tolerance and avoidance mechanisms to some degree. However, avoidance has greater survival value than tolerance because these plants can continue growth and development while the tolerant plants can only survive. (Mertz-PTT)
W90-03272

RESPONSE OF FIVE FOOD LEGUME CROPS TO AN IRRIGATION GRADIENT IMPOSED DURING REPRODUCTIVE GROWTH.
Chiang Mai Univ. (Thailand). Faculty of Agriculture.
For primary bibliographic entry see Field 3F.
W90-03279

FRACTION OF THERMAL UNITS AS THE BASE FOR AN EVAPOTRANSPIRATION CROP COEFFICIENT CURVE FOR CORN.
Saint Rose School, Belmar, NJ.
For primary bibliographic entry see Field 2D.
W90-03281

COTTON CANOPY AND DRYING EFFECTS ON RUNOFF DURING IRRIGATION WITH MOVING SPRINKLER SYSTEMS.
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Inst. of Soil and Water.
For primary bibliographic entry see Field 3F.
W90-03283

SPRINKLER IRRIGATION EFFECTS ON DETERMINATE SOYBEAN YIELD AND LODGING ON A CLAY SOIL.
Louisiana Agricultural Experiment Station, St. Joseph. Northeast Research Station.
For primary bibliographic entry see Field 3F.
W90-03284

TRANSPIRATION EFFICIENCY OF OAT.
Goettingen Univ. (Germany, F.R.). Inst. of Agronomy and Plant Breeding.
For primary bibliographic entry see Field 2D.
W90-03285

WATER-USE EFFICIENCY AND LIGHT INTERCEPTION OF SEMIDWARF AND STANDARD-HEIGHT SUNFLOWER HYBRIDS GROWN IN DIFFERENT ROW ARRANGEMENTS.
Universidade Federal da Paraiba, Areia (Brazil). Dept. of Crop Science.
For primary bibliographic entry see Field 3F.
W90-03286

RESPONSE OF BANANA TO DRIP IRRIGATION, WATER AMOUNTS AND FERTILIZATION REGIMES.
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
For primary bibliographic entry see Field 3F.

W90-03294

RELATIONSHIP BETWEEN WATER SOLUBLE AND EXCHANGEABLE SOIL CATIONS FOR ESTIMATING PLANT UPTAKE AND LEACHING POTENTIAL.
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
For primary bibliographic entry see Field 2G.
W90-03297

EFFECT OF TWO SOIL MOISTURE LEVELS AND WETTING-DRYING CYCLES ON MANGANESE RELEASE IN NACL-AMENDED SOILS.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 2G.
W90-03302

TOMATO RESPONSE TO TRICKLE IRRIGATION AND BLACK POLYETHYLENE MULCH.
Agricultural Research Service, Charleston, S.C. Vegetable Lab.
For primary bibliographic entry see Field 3F.
W90-03318

WATER RELATIONS OF GRAPEFRUIT TREES IN RESPONSE TO DRIP, MICROSPRINKLER, AND OVERHEAD SPRINKLER IRRIGATION.
Citrus Research and Education Center, Lake Alfred, FL.
For primary bibliographic entry see Field 3F.
W90-03319

DEPLETION OF HEAVY ISOTOPES OF OXYGEN AND HYDROGEN IN TISSUE WATER OF INTERTIDAL PLANTS: IMPLICATIONS FOR WATER ECONOMY.
California Univ., Los Angeles. Dept. of Earth and Space Sciences.
L. W. Cooper, and M. J. DeNiro.
Marine Biology MBIOAJ, Vol. 101, No. 3, p 397-400, 1989. 3 fig, 1 tab, 24 ref. NSF Grant No. DMB 84-05003 and DOE Grant No, DE-87ER60615.

Descriptors: *Deuterium, *Oxygen isotopes, *Tissue analysis, *Plant tissues, *Sea grasses, *Marine algae, Algae, Aquatic plants, Littoral environment, Intertidal areas, California.

Stable oxygen and hydrogen isotope ratios of leaf and thallus water of the intertidal sea grasses Phyllospadix scouleri and P. Torreyi and the marine algae Egregia menziesii, Gelidium coulteri, and Corallina vancouverensis from three locations in California, were determined in 1987. Compared with subtidal seawater, most plant-water samples were depleted in the heavy isotopes (18)O and deuterium. Depletion of heavy isotopes was greatest in plants growing at the highest intertidal elevations. This was an unexpected result, because enrichment of heavy isotopes occurs during evapotranspiration in terrestrial plants. Two possible mechanisms for this isotopic depletion are proposed: direct uptake of heavy isotope-depleted water vapor and preferential diffusion of (16)O and (1)H into littoral plants from water remaining in the intertidal zone at low tide. (Author's abstract)
W90-03342

SEASONAL SOIL WATERLOGGING INFLUENCES WATER RELATIONS AND LEAF NUTRIENT CONTENT OF BEARING APPLE TREES.
Maine Univ. at Orono. Dept. of Plant and Soil Sciences.
For primary bibliographic entry see Field 3F.
W90-03366

OXYGEN-18 CONTENT OF ATMOSPHERIC OXYGEN DOES NOT AFFECT THE OXYGEN ISOTOPE RELATIONSHIP BETWEEN ENVI-

RONMENTAL WATER AND CELLULOSE IN A SUBMERGED AQUATIC PLANT, EGERIA DENSA PLANCH.
California Univ., Los Angeles. Dept. of Earth and Space Sciences.
L. W. Cooper, and M. J. DeNiro.
Plant Physiol PLPHAY, Vol. 91, No. 2, p 536-541, October 1989. NSF Grants DMB 84-05003 and DCB 88-96201, and DOE Grant DE-87ER60615.

Descriptors: *Limnology, *Paleolimnology, *Oxygen isotopes, *Paleoclimatology, *Aquatic plants, *Oxygen uptake, *Plant physiology, Stable isotopes, Biosynthesis, Submerged plants.

It was determined that the oxygen isotopic composition of cellulose synthesized by a submerged plant, Egeria densa Planch., is related to the isotopic composition of environmental water by a linear function. The observation of a slope of less than 1 indicated that a portion of cellulose oxygen is derived from an isotopically constant source other than water. To determine whether this source might be molecular oxygen, plants were grown in the presence of high concentrations of (18)O in the form of O2 bubbled into the bottom of an aquarium. Cellulose synthesized during this experiment did not have significantly different oxygen isotope ratios than that synthesized by control plants exposed to O2 of normal (18)O abundance. It is proposed that oxygen in organic matter recycled from senescent portions of the plant is incorporated into cellulose. Findings indicate that paleoclimatic models linking the oxygen isotope composition of environmental water to cellulose from fossil plants will have to be modified to account for contributions of oxygen from this or other sources besides water. (Author's abstract)
W90-03450

2J. Erosion and Sedimentation

SUSPENDED SEDIMENT FLOW MODEL FOR HIGH SOLIDS CONCENTRATION USING HIGHER ORDER TURBULENCE CLOSURE.
Southern Illinois Univ. at Carbondale. Dept. of Civil Engineering and Mechanics.
B. A. DeVantier, and R. Narayanaswamy.
Advances in Water Resources AWREDI, Vol. 12, No.1, p 46-52, March 1989. 7 fig, 15 ref.

Descriptors: *Suspended sediments, *Path of pollutants, *Fluid flow, *Sediment transport, *Suspended load, *Model studies, *Turbulent flow, Suspended solids, Vertical distribution, Momentum transfer, Pollutants, Kinetic energy, Density stratification, Eddy diffusion, Buoyancy.

Many models have been proposed to predict the vertical distributions of velocity and solids in sediment-laden flows. Recent concerns about the transport of pollutants bound to suspended sediment have sparked renewed interest in the improvement of the predictive capabilities of such models. Models which have the capability to predict turbulent transport effects accurately for fluid momentum, suspended sediment, and dissolved contaminants, all at the same time, are highly desirable. A predictive model of sediment-laden flows using a second order closure is presented. Damping of turbulence due to the presence of suspended solids is included in the model through consideration of local damping of turbulence kinetic energy. A modified Launder-Spaulding model is used which utilizes damping terms to account for both sediment-induced density stratification and particle interference with eddy motions. Comparisons of model predictions for solids and velocity vertical distributions to measurement are presented for both negatively buoyant and neutrally buoyant solids with good agreement. Free surface damping of turbulence is also included in the model. The addition of the effect of solids damping is significant but it should only be important at high solids concentrations. (Fish-PTT)
W90-02550

ATTEMPT TO SYNTHESIZE KNOWLEDGE ON MOUNTAIN EROSION AND TORRENTIAL HYDRAULICS (ESSAI DE SYNTHESE

DES CONNAISSANCES EN EROSION ET HYDRAULIQUE TORRENTIELLE).
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Saint-Martin d'Heres (France). Grenoble Group.
M. Meunier.
Houille Blanche HOBLAB, No. 5, p 361-375, 1989. 12 fig, 48 ref. English summary.

Descriptors: *Erosion, *Hydraulic engineering, *Hydraulics, Flow discharge, Mountains, Catchment areas, France.

Studies of erosion and hydraulics sciences have been performed in relation to the mountain catchments of France. It is pointed out that the level of technical studies in erosion and hydraulics is not at the same level of development. In the area of mountain erosion the reliability of data is determined by the relationship between rain, the liquid flow and solid flow which in turn depends on the geologic nature of the soil. Therefore, only empirical data can be used which is specific for each project. Torrential hydraulics, on the other hand, is less dependent on the nature of the soil, and therefore, data developed on models can be utilized on various projects. (Peters-PTT)
W90-02553

CESIUM 137 AND LEAD 210 IN ALPINE LAKE SEDIMENTS: MEASUREMENTS AND MODELING OF MIXING PROCESSES.
Laboratoire de Glaciologie et Geophysique de l'Environnement, Saint-Martin d'Heres (France).
M. Pourchet, J. F. Pinglot, and M. A. Melieres.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 94, No. 9, p 12,761-12,770, September 15, 1989. 5 fig, 3 tab, 43 ref.

Descriptors: *Radioactive dating, *Paleohydrology, *Lake sediments, *Sedimentation rates, *Mixing, *Cesium radioisotopes, *Lead radioisotopes, Core logging, Deposition, Alpine regions, Simulation analysis, Sediment distribution.

Sediments are commonly used as records of the past. Often, the surface sediment layer, which corresponds to an event well-defined in time, is perturbed by different phenomena (mixing) over a depth of several centimeters. This mixing broadens the record of deposition, thus reducing the time resolution of the events recorded in the sediments. Therefore interpreting a core requires determination of at least two parameters: the sedimentation rate and the mixing characteristics. This is usually achieved by measuring the distribution of radionuclides. Simulations of Cesium 137 (Cs137) distribution in lake sediment cores are presented for slow and rapid mixing processes, for different mixing layers, and for different sampling thicknesses. A parameter characterizing the profile distribution is introduced. Interpretation of the Cs137 profiles of seven alpine lakes is given using those simulations leading to an estimate of the sedimentation rate, the type of mixing and the thickness of the mixing layer. These parameters are compared with those obtained independently from lead 210 (Pb210) profiles in three of the lakes. Agreement is satisfactory. The lakes studied have similar features. In most cases, the lakes have mixing which can be approximated by a rapid diffusion process, sedimentation rate of the order of 0.01 gm/sq cm/yr and a mixing layer of the order of 2-4 centimeters. (Fish-PTT)
W90-02568

DEPOSITIONAL EVOLUTION OF A WINDWARD, HIGH-ENERGY LAGOON, GRAHAM'S HARBOR, SAN SALVADOR, BAHAMAS.
Miami Univ., Oxford, OH. Dept. of Geology.
For primary bibliographic entry see Field 2L.
W90-02581

SCALING AND ELEVATION IN RIVER NETWORKS.
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
For primary bibliographic entry see Field 2E.
W90-02591

PARAMETRIC MODEL FOR STEEPLY SLOPING FORESTED WATERSHEDS.
Kentucky Univ., Lexington. Dept. of Civil Engineering.
L. E. Ormsbee, and A. Q. Khan.
Water Resources Research WRERAQ, Vol. 25, No. 9, p 2053-2065, September 1989. 6 fig, 8 tab, 25 ref.

Descriptors: *Geomorphology, *Rainfall-runoff relationships, *Forest watersheds, *Infiltration capacity, *Soil absorption capacity, *Model studies, *Parametric hydrology, Surface-groundwater relations, Forest management, Slopes, Rainfall intensity, Watershed management, Hydrographs, Storm seepage, Flow characteristics, Runoff volume, Humid areas, Interstitial water, Flood peak, Seasonal variation, West Virginia, Kentucky, Interstitial water.

In humid regions, such as the Appalachian region of eastern Kentucky, the infiltration capacity of the soil generally remains much higher than the average rainfall intensity. With the objective of simulating storm hydrographs in steeply-sloping forested watersheds in humid regions, the kinematic storage model of Sloane and Moore was embedded into an existing watershed model (HEC 1) and applied to a set of selected watersheds in West Virginia and eastern Kentucky. Because of the marginal performance of the model, a more comprehensive model structure was developed which explicitly considers both macropore and micropore flow mechanisms. Application of the new model to the selected watersheds produced much better correlations between the observed and predicted watershed responses such as the runoff volume, the peak discharge, and the time to peak. Calibrated model parameters were found to exhibit a strong seasonal dependency. As a result, it was concluded that the underlying response mechanisms are highly influenced by seasonal changes in both the surface and subsurface characteristics of the watersheds. (Author's abstract)
W90-02592

POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS IN SELECTED ESTUARINE SEDIMENTS.
Environmental Protection Agency, Narragansett, RI. Environmental Research Lab.
For primary bibliographic entry see Field 5B.
W90-02604

EFFECT OF EXPORTED MANGROVE LITTER ON BACTERIAL PRODUCTIVITY AND DISSOLVED ORGANIC CARBON FLUXES IN ADJACENT TROPICAL NEARSHORE SEDIMENTS.
Australian Inst. of Marine Sciences, Townsville.
For primary bibliographic entry see Field 2L.
W90-02682

CHANGES IN SALMON SPAWNING AND REARING HABITAT FROM INCREASED DELIVERY OF FINE SEDIMENT TO THE SOUTH FORK SALMON RIVER, IDAHO.
For primary bibliographic entry see Field 4C.
W90-02689

PREDICTION OF REWORKING OF THE BANKS OF LOWER RESERVOIRS OF PUMPED-STORAGE STATIONS.
V. F. Kanarskii, S. V. Kukhtii, Y. N. Vasilev, E. F. Zhila, and A. A. Evtushok.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 2, p 73-79, August 1989. 3 fig, 2 tab, 14 ref.

Descriptors: *Bank erosion, *Reservoirs, *Dnestr River, *Hydroelectric plants, *Bank protection, *USSR.

The unprotected bank slopes of the lower reservoir of a pumped-storage station are subjected to a set of daily effects of an unsteady character--fluctuations of the water level, flows, longshore currents, seepage of water into the banks, waves, ice, etc., which are superimposed on the natural course of

Group 2J—Erosion and Sedimentation

development of these slopes. The probability of combinations of various effects on the slope increases in the lower reservoir serving several hydropower plants operating under different daily and seasonal regimes. An example is the lower reservoir of the Dnestr pumped-storage station (U.S.S.R.) with a daily regime of regulation. Depending on the character and intensity of the effect of the aforementioned factors, deformation disturbing the strength and stability of the rocks occur in the bank slopes and their profile is reworked. This process is complex and insufficiently studied. Prediction of this process is complicated since the wave effects on the banks of the lower reservoir of a pumped-storage station are usually not the dominant ones, and the existing methods of predicting the reworking of banks (in this case, 30 of them) developed on the basis of this type of effect are unacceptable naturally, under the given conditions. Ways are being sought to solve the problems of reworking the banks on the basis of the type of effects on the banks. Thus, with reference to the lower reservoir of the Dnestr pumped-storage station, an attempt was made to evaluate reworking of the banks with consideration of the level of regime of the lower reservoir and other factors. Calculations were made on the basis of a model of geohydromorphological similarity with reference to various types of slopes characterized by certain geomorphological parameters, geological and lithological structure, hydrogeological conditions, and effect of a set of natural and technological factors. Unfortunately, the calculations were not accurate and should be refined by data of subsequent onsite observations and investigations. (Mertz-PTT)
W90-02693

DISTRIBUTION OF WATER DISCHARGES AND CURRENT VELOCITIES IN A BRAIDED CHANNEL.
V. G. Salikov.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 2, p 88-91, August 1989. 2 fig 1 tab, 2 ref.

Descriptors: *Channel morphology, *Alluvial channels, *Sediment transport, *Open-channel flow, *Rivers, *Hydraulic engineering, *Braided streams, Channel flow, Model studies.

Braided channels of flatland rivers are being widely used in the economy: navigation, fisheries, hydrotechnical construction, water supply, transformation of the river system and redistribution of runoff in town planning. When designing, constructing, and operating various structures in basins of these rivers the correctness of the hydraulic calculation of the distribution of water discharges and current velocities in a braided channel is of great importance. Investigation of an aerodynamic model of two rivers and four channels provided the distribution fo the discharge and current velocities in braided channels of a flatland river under natural conditions. The regularities of fluid flow at the point of separation were established, which had a substantial effect on the results of calculating the distribution of the discharge in the channels. Detailing of the calculations of the distribution of the discharge in channels by means of the main equation of uniform motion without considerations of the regularities of fluid motion at the point of separation leads to an increase of the deviation of the results obtained from the actual data. The results of the investigation have importance for developing optimal variants of structures being designed and increasing the reliability of existing structures, for improving the navigation conditions on rivers with an analogous scheme of braiding of the flow since they reflect the characteristics of the distribution of discharges and velocities in a braided channel under various conditions which are not being taken into account by the existing hydraulic calculation methods. (Mertz-PTT)
W90-02696

FORMATION OF SAND RIDGES IN CANALS.
O. N. Melnikova, O. B. Shevchenko, and Y. G. Pyrkin.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 2, p 91-95, August 1989. 4 fig, 11 ref.

Descriptors: *Sediment transport, *Open-channel flow, *Channel morphology, *Channel flow, *Model studies, *Rivers, *Flow discharge, *Flow velocity, Dunes.

A new physical model of the process of the occurrence and development of ridges on a bed of a channel flow is proposed on the basis of theoretical conclusions and experimental data. The process of formation of ridges on a sand bed in a straight channel of parabolic cross section was investigated. The top width was 1 m, length 15 m, bottom slope 0.0011, average diameter of the particles composing the bed, 0.2 mm. The experiment was conducted at a constant water discharge of 88.9 l/sec. In the upper part of the channel the flow was uniform, the maximum velocity on the channel line was 34 cm/sec. A backwater was maintained in the lower part of the channel; this caused the velocity to vary form 34-30 cm/sec in the direction of flow. In the upper part, channel depth of flow was 5.5 cm. It was established that three types of ridges correspond to the structural level of microforms: on the majority of rivers the short rivers are dunes, ripples are 2-3 times longer than dunes, and spits are 2-3 times longer than ripples. A comparison of the calculated data and actual data showed that the size of the ridges actually observed were described well by the proposed physical model. (Mertz-PTT)
W90-02697

SUSPENDED SEDIMENTS AND THE DISTRIBUTION OF BOTTOM SEDIMENTS IN THE NIAGARA RIVER.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
A. Mudroch, and D. Williams.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 3, p 427-436, 1989. 6 fig, 2 tab, 22 ref.

Descriptors: *Sediment transport, *Path of pollutants, *Sonar, *Niagara River, *Lake Ontario, *Bottom sediments, Geophysical surveys, River beds, Suspended sediments, Deposition.

A geophysical survey was conducted in 1983/84 to obtain information on the character and distribution of bottom sediments in the Niagara River. A combination side-scan sonar and sub-bottom profiler was used in the survey of the river bed. The results of the survey showed a lack of deposition of fine-grained sediments on the river bed. Coarse sand, gravel, glaciolacustrine clay and till, and bedrock were major components of the bottom deposits in the river. Fine-grained sediments were located only at a few areas in the lower part of the Niagara River. The estimated thickness of these deposits was about 10 cm and they occurred as small patches, often < 1 sq m. Many contaminants entering the Niagara River, in a soluble or particulate form, become associated with the suspended load, consisting mainly of fine-grained particles. The lack of depositional areas for fine-grained particles in the Niagara River results in the transport of particle-associated contaminants into the depositional zones of Lake Ontario. (Author's abstract)
W90-02749

CLIMATOLOGY OF SEDIMENT TRANSPORT ON INDIANA SHOALS, LAKE MICHIGAN.
Argonne National Lab., IL. Biological, Environmental, and Medical Research Div.
B. M. Lesht.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 3, p 486-497, 1989. 9 fig, 2 tab, 17 ref.

Descriptors: *Lake Michigan, *Great Lakes, *Sediment transport, Indiana Shoals, Time lapse photography, Mathematical models, Bottom sediments, Wave velocity, Suspended sediments.

Seven time-lapse films of the lake bottom covering 2,445 hours of observation were made over a period of 3 years during the months of July through November on Indiana Shoals in southwestern Lake Michigan (water depth 10 m). These films show 25 distinct sediment transport events, consisting of periods of bedform migration or sediment resuspension and occupying approximately 25% of the total record. Simultaneous observations of the surface winds showed that most of the sediment transport occurred during periods of northerly winds, implying that surface waves were the predominant mechanism for sediment remobilization at this location. A simple, empirical, sediment transport forecast model was used to determine threshold criteria for the initiation of bedload and resuspension of the local sediments (fine-medium sand). The model correctly predicted 85% of the total record when forced with estimates of the near-bottom wave orbital velocity calculated from the wind measurements and a parametric dynamical wave model. The critical wave orbital velocity for resuspension was found to be 17.8 cm/s. Estimates of the probability of sediment transport occurring on Indiana Shoals, determined as a function of wind speed and direction, were combined with climatological observations of wind conditions to estimate monthly probabilities of sediment transport. These probabilities are in agreement with previous forecasts based on historical observation of the Great Lakes wave climate. (Author's abstract)
W90-02755

TILLAGE AND RAINFALL EFFECTS ON RANDOM ROUGHNESS: A REVIEW.
Agricultural Research Service, Big Spring, TX.
For primary bibliographic entry see Field 3F.
W90-02775

FREMONT LAKE, WYOMING--SOME ASPECTS OF THE INFLOW OF WATER AND SEDIMENT.
Geological Survey, Denver, CO. Water Resources Div.
W. W. Emmett, and R. C. Averett.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4021, 1989. 25p, 12 fig, 8 tab, 15 ref. Project CR187.

Descriptors: *Silting, *Sediment load, *Streamflow, *Wyoming, Bed load, Suspended load, Sediment transport, Surface water, Lakes, Lake sediments, Lake morphology, Deltas, Fremont Lake.

Fremont Lake is a large (20.6 sq km), deep lake (185 m) in western Wyoming. Average annual inflow of water is about 5.1 cu meters/sec, and this discharge is equaled or exceeded about 23% of the time. Annual instantaneous peak flows of Pine Creek usually exceed 30 cu m/sec and the 100-year flood is about 80 cu m/sec. About 800 tons of sediment are delivered to the lake annually; annual deposition of sediment in the northern lake area throughout the last 10,000 years about equals contemporary values of sediment inflow. Only small quantities of fine-gradient sediment are transported beyond the delta at the northern end of the lake. Current rates of deposition in the delta are about 1 to 3 mm/yr. Sediment in the delta generally is sand size; elsewhere in the lake, sediment generally is clay and silt size. (USGS)
W90-02849

MONTHLY AND ANNUAL SUSPENDED-SEDIMENT LOADS IN THE BRAZOS RIVER IN RICHMOND, TEXAS, 1966-86 WATER YEARS.
Geological Survey, Austin, TX. Water Resources Div.
F. L. Andrews.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4216, 1989. 20p, 9 fig, 2 tab, 13 ref.

Descriptors: *Data collections, *Suspended sediments, *Stream discharge, *Texas, *Brazos River, Suspended load, Sediment data, Streamflow data.

Sampling to determine suspended-sediment concentrations at Brazos River at Richmond, Texas, station 08114000 began in January 1966 and ended in September 1986. Depth-integrated samples were collected in all flow conditions. The records for this station are considered good. The mean monthly suspended-sediment load in the Brazos River at Richmond ranged from 2,500 to 91,000 tons during

the period of record. The annual suspended-sediment load at Brazos River at Richmond ranged from 404,500 to 30,800,000 tons and averaged about 10,900,000 tons. The minimum annual load of 404,500 tons occurred during the 1984 water year, and the maximum annual load of 30,800,000 tons occurred during the 1968 water year. Suspended-sediment load and discharge varied throughout the period of study. A double-mass curve indicated that the relation between discharge and sediment load remained constant. No breaks were noted, indicating that no change occurred in the relation. The data collected annually during the study were used to define a regression model. The model was found to be a good predictor of annual suspended-sediment load by using annual streamflow as the independent variable. (USGS) W90-02854

GLACIAL DEPOSITS.
Dames and Moore, Phoenix, AZ.
For primary bibliographic entry see Field 2F.
W90-02901

LANDFORM DEVELOPMENT.
California Univ., Davis. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-02908

LANDFORM DEVELOPMENT; KARST.
McMaster Univ., Hamilton (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2F.
W90-02909

GENERATION AND DISSIPATION OF ABNORMAL FLUID PRESSURES IN ACTIVE DEPOSITIONAL ENVIRONMENTS.
Texas A and M Univ., College Station. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-02911

FLOODS: HYDROLOGICAL, SEDIMENTOLOGICAL AND GEOMORPHOLOGICAL IMPLICATIONS.
For primary bibliographic entry see Field 2E.
W90-02963

HYDROLOGY, SEDIMENTOLOGY AND GEOMORPHOLOGICAL IMPLICATIONS OF FLOODS: AN OVERVIEW.
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 2E.
W90-02964

STORM RUNOFF GENERATION IN SMALL CATCHMENTS IN RELATION TO THE FLOOD RESPONSE OF LARGE BASINS.
Oxford Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-02965

FLOOD FREQUENCY AND URBAN-INDUCED CHANNEL CHANGE: SOME BRITISH EXAMPLES.
College of St. Paul and St. Mary, Cheltenham (England). Dept. of Geography and Geology.
For primary bibliographic entry see Field 2E.
W90-02968

HYDRAULICS OF FLOOD CHANNELS.
Birmingham Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02969

FLOW-COMPETENCE EVALUATIONS OF THE HYDRAULIC PARAMETERS OF FLOODS: AN ASSESSMENT OF THE TECHNIQUE.
Oregon State Univ., Corvallis. Coll. of Oceanography.
P. D. Komar.
IN: Floods: Hydrological, Sedimentological and Geomorphological Implications. John Wiley & Sons, New York. 1989. p 107-134. 9 fig, 50 ref.

Descriptors: *Channel erosion, *Scour, *Sediment transport, *Entrainment, *Flow competence, *Flood flow, *Flood discharge, Floods, Channel morphology.

Because of recent studies of selective entrainment of gravels from deposits of mixed sizes, flow competence evaluations can now better account for such sorting processes. Comparisons of past data demonstrate their inadequacy and tendency to over-estimate floodflow stresses and discharges significantly. Competence evaluations should instead be based on selective-entrainment relationships which yield the mean-flow stress, and on data which gives the discharge per unit flow width. Once those estimates have been made, corrections or refinements are possible which account for steep channel slopes and low ratios of flow depths to bed roughness. Therefore, if flow competence is recognized as a process of selective entrainment, then the technique is valid and it is possible to make reasonable assessments of flood hydraulics. In all cases, attempts should be made at independent confirmations of the results. (See also W90-02963) (Mertz-PTT)
W90-02970

FLOODS AND FLOOD SEDIMENTS AT RIVER CONFLUENCES.
Birkbeck Coll., London (England).
For primary bibliographic entry see Field 2E.
W90-02971

FLOOD EFFECTIVENESS IN RIVER BASINS: PROGRESS IN BRITAIN IN A DECADE OF DROUGHT.
Newcastle upon Tyne Univ. (England).
For primary bibliographic entry see Field 2E.
W90-02972

USE OF SOIL INFORMATION IN THE ASSESSMENT OF THE INCIDENCE AND MAGNITUDE OF HISTORICAL FLOOD EVENTS IN UPLAND BRITAIN.
Brighton Polytechnic (England). Countryside Research Unit.
For primary bibliographic entry see Field 2E.
W90-02974

YELLOW RIVER (COUNTY LEITRIM IRELAND) FLASH FLOOD OF JUNE 1986.
Trinity Coll., Dublin (Ireland). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-02975

RIVER CHANNEL CHANGES IN RESPONSE TO FLOODING IN THE UPPER RIVER DEE CATCHMENT, ABERDEENSHIRE, OVER THE LAST 200 YEARS.
College of St. Paul and St. Mary, Cheltenham (England). Dept. of Geography and Geology.
For primary bibliographic entry see Field 2E.
W90-02976

SEDIMENTOLOGY AND PALAEOHYDROLOGY OF HOLOCENE FLOOD DEPOSITS IN FRONT OF A JOKULHLAUP GLACIER, SOUTH ICELAND.
Aberdeen Univ. (Scotland). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-02977

FLOOD DEPOSITS PRESENT WITHIN THE SEVERN MAIN TERRACE.
For primary bibliographic entry see Field 2E.
W90-02978

PRACTICAL ASPECTS FOR THE APPLICATION OF THE DIFFUSION-CONVECTION

THEORY FOR SEDIMENT TRANSPORT IN TURBULENT FLOWS.
Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.).
W. Bechteler.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 351-356, 4 fig, 6 ref.

Descriptors: *Diffusion, *Convection, *Model studies, *Sediment transport, *Turbulent flow, *Hydrologic models, Mathematical models, Mathematical equations, Open-channel flow, Sand, Eddy diffusion.

The sediment transport of sand-sized particles in turbulent flow is described by means of the two-dimensional diffusion-convection equation. The influence of scattering or distributed input parameters on settling rates of suspended material is evaluated. Investigations are described concerning: (1) the boundary conditions at the initial cross section and at the bottom, (2) the turbulent diffusion coefficient, and (3) the fall velocity (distribution of the solids). For many practical cases, the fall velocity and inlet concentration profile are of greatest importance, whereas the influence of turbulence can be taken into account by an integral value of the turbulent diffusion coefficient. (See also W90-02980) (Author's abstract)
W90-03030

GEOMORPHOLOGICAL APPROACH TO ENGINEERING IN KARST.
Bergen Univ. (Norway). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-03185

SCOUR-DEPTH PREDICTION UNDER ARMORING CONDITIONS.
Cook Coll., New Brunswick, NJ. Dept. of Biological and Agricultural Engineering.
D. K. Borah.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 10, p 1421-1425, Oct 1989. 1 fig, 1 tab, 10 ref.

Descriptors: *Bed armoring, *Scour, *Channel erosion, *Channel scour, *Alluvial channels, *Canal design, *Sediment transport, *Sediment-carrying capacity, *Canal linings, Bed load, River beds, Project planning, Hydraulic engineering, Hydraulic structures, Scour, Prediction.

Accurate prediction of scour depth may assist in engineering planning and design involving water flow over an alluvial bed. Bed scour on an alluvial bed is the result of imbalance between the sediment transport capacity of the flow and the amount of sediment coming along with the flow. If the sediment transport capacity is higher than the incoming sediment rate, bed scour will take place until these two become equal. The larger and heavier particles, which are nontransportable under the flow conditions, remain on the bed and gradually occupy the entire bed surface. As soon as this is the case, bed scour stops. This layer of coarse particles is called the armor layer. Such a layer will protect the underlying finer particles until it is destroyed by higher flow conditions. In this note, a simple procedure is presented for calculating the scour depth on an alluvial bed under armoring conditions. It was used to predict scour depths in Little and Mayer's flume and downstream from Gavins Point Dam. The procedure is applicable to only graded bed materials with a size distribution having adequate quantity of critical and bigger size particles to form an armor layer. Calculation of scour depth requires flow depth, bed slope, bed porosity, particle size distribution of the bed material, and a few commonly available constants. The bed porosity, the fraction of the armor particles, and the median particle size are estimated from analyses of bed material samples. The procedure can serve as a useful tool for field and design

engineers in making conservative estimates of scour depths downstream of hydraulic structures and in new unlined canals as well as in selecting materials for canal beds. (Ence-PTT)
W90-03225

ACID-PERSULFATE DIGESTION PROCEDURE FOR DETERMINATION OF PHOSPHORUS IN SEDIMENTS.
Southern Forest Experiment Station, Oxford, MS.
Forest Hydrology Lab.
For primary bibliographic entry see Field 7B.
W90-03291

MODELLING CLOD BREAKDOWN BY RAINDROP ENERGY ON A FERSIALLITIC CLAY SOIL.
Institute of Agricultural Engineering, Harare (Zimbabwe).
H. A. Elwell.
Soil and Tillage Research SOTRD5, Vol. 14, No. 3, p 241-257, Aug 1989. 5 fig, 6 tab, 17 ref.

Descriptors: *Soil erosion, *Model studies, *Soil properties, *Clays, *Mathematical models, *Rainfall impact, *Soil water, Soil clods, Field tests, Model studies.

A mathematical model descriptive of the process of clod breakdown under rainfall energy and burial by deposition of detached particles in the interstices between clods was developed in the laboratory under simulated rainfall and tested against field plot data. Clods were conceptualized as hemispheres to provide a basis for modelling, from which the detachment of soil in a uniform vertical depth over the entire exposed surface of the clod corresponded with observed changes in clod geometry. An empirical component showed that, on this soil type, the rate of detachment of soil from the clod surface depended upon the percentage of water-stable aggregates greater than 2 mm diameter in the soil forming the clod and the amount of roots binding the aggregates into a clod unit. During field testing, clods were found to break down at considerably faster rates than those determined in the laboratory owing to greater clod friability caused by wetting and drying cycles and field operations. (Author's abstract)
W90-03381

RIVER-MEANDER MODEL: I. DEVELOPMENT.
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
For primary bibliographic entry see Field 2E.
W90-03393

RIVER-MEANDER MODEL: II. APPLICATIONS.
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
For primary bibliographic entry see Field 2E.
W90-03394

MODELING OF RIVERBED EVOLUTION FOR BEDLOAD SEDIMENT MIXTURES.
Laboratoire d'Hydraulique de France, Grenoble.
For primary bibliographic entry see Field 8B.
W90-03397

APPLICABILITY INDEX FOR SAND TRANSPORT EQUATIONS.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
D. T. Williams, and P. Y. Julien.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 11, p 1578-1581, November 1989. 2 fig, 1 tab, 8 ref.

Descriptors: *Sediment transport, *Mathematical equations, Sand, Alluvial rivers.

The selection of an appropriate sediment transport equation has puzzled river engineers and computer modelers confronted with the analysis of the alluvial river response to natural and man-induced changes. Although some guidelines have been proposed, the complexity of sediment transport processes as has been recognized by most investigators warrants further investigation. This paper describes the results of a preliminary investigation of the condition of applicability and inherent limitation of sediment transport relationships, which should be conducive to an implementation of existing guidelines. The four sediment transport equations selected in this preliminary analysis are those of Ackers and White, Shen and Hung, Toffaleti, and Yang. (Sand-PTT)
W90-03400

USE OF TEXTURAL (CM) PATTERN FOR IDENTIFICATION OF DEPOSITIONAL PROCESSES AND ENVIRONMENTS OF SEDIMENTS OF THE CAUVERY DELTA.
Cochin Univ. of Science and Technology (India).
School of Marine Sciences.
P. Seralathan.
Bulletin of the Department of Marine Sciences University of Cochin, Vol. 14, p 17-26, 1986-88. 4 fig, 1 tab, 11 ref.

Descriptors: *Sedimentology, *Sedimentation, *Deltas, *Sediment grading, *Sediment transport, River channels, Estuaries, Cauvery Delta, India.

Grain size parameters from nine suits of river channel, estuary, tidal channels, marine, mangrove, swamps, beach, dune and ancient beach ridges of the Cauvery delta have been studied using CM, FM, LM and AM techniques of Passega and Passega et al, in order to know the nature of transport and depositional processes. In this system, M is the median grain size and the first letter represents the limiting size: F, L, and A represent the percentage by weight of samples finer than 125, 31, and 4 microns, respectively. In the river channel, except some samples which are transported as graded suspension, a majority of the sediments are transported by a combination of rolling and suspension only. Uniform suspension is completely missing. The estuarine sediments are transported partly by suspension and rolling and partly by graded and uniform suspensions. The tidal channel sediments are transported primarily by uniform suspension with some rolling and suspension and graded suspension. On the other hand, the marine sediments are the products of uniform suspension only. The mangrove and swampy sediments clearly indicate their quiet water characteristics. The dune sands are transported exclusively by graded suspension while those of beach and ancient beach ridges are both by graded suspension as well as suspension and rolling. (Author's abstract)
W90-03452

CLAY MINERALOGY OF THE SEDIMENTS OF THE ASHTAMUDY ESTUARY, WEST COAST OF INDIA.
Cochin Univ. of Science and Technology (India).
School of Marine Sciences.
K. Sajan, and K. T. Damodaran.
Bulletin of the Department of Marine Sciences University of Cochin, Vol. 14, p 67-74, 1986-88. 1 tab, 16 ref.

Descriptors: *Kaolinite, *Montmorillonite, *Estuaries, *Sedimentology, *Clay minerals, Ashtamudy Estuary, India.

Study on 21 clay samples from the sediments of the Ashtamudy estuary revealed the dominance of kaolinite and montmorillonite along the eastern and western parts of the estuary respectively where as the central part the sediments contain more or less equal proportions of them. The clay minerals in the sediments of the Ashtamudy estuary undergo limited chemical changes and the reflect mainly the source material supplied to the estuary. There is a dual source of sediment supply to the estuary: the Kallada river input which is kaolinite rich; and the off-shore sediments which are rich in montmorillonite. The present clay mineral distribution pattern in estuary sediments can be attributed to the effect of the estuarine circulation which sorts the clay minerals. (Author's abstract)
W90-03454

DISPERSAL AND DEPOSITION OF RIVER SEDIMENTS IN COASTAL SEAS: MODELS FROM ASIA AND THE TROPICS.
Virginia Inst. of Marine Science, Gloucester Point.
L. D. Wright.
Netherlands Journal of Sea Research NJSRBA, Vol. 23, No. 4, p 493-500, August 1989. 5 fig, 1 tab, 25 ref.

Descriptors: *Asia, *Sediment transport, *River systems, *Sediment discharge, Model studies, Yellow River, Bahai Gulf, Purari River, Jaba River, Gulf of Papua, Suspended sediments, Bed load, Slopes.

The diverse mechanisms by which river-borne sediments are dispersed into coastal oceans and the associated patterns of deposition are considered for some tropical and Asian river mouth dispersal systems: the Huanghe (Yellow River), which enters the Bohai Gulf (China), the Purari River which enters the Gulf of Papua (Papua New Gunina) and the Jaba River, which enters Empress Augusta Bay (Bougainville, Papua New Guinea). These models contrast sharply with 'conventional' models such as that of the Mississippi, although in different respects. Extremely high suspended sediment concentrations off the Huanghe mouth cause sinking, gravity-driven plumes which produce rapid deposition very near the mouth; extremely rapid seaward growth of the subaqueous delta results. Although the average water discharge of the Huanghe exceeds that of the Huanghe, the average sediment discharge from the Purari is an order of magnitude less than that of the Huanghe. Suspended sediments transported via buoyant plumes from the Purari mouth are trapped inshore by the southeasterly trades and have their ultimate sink in the tidal estuaries to the west of the mouths rather than offshore. The Jaba is a small river with a very steep gradient and an extremely high bed load relative to water discharge. It has constructed a protruding and rapidly evolving delta. Literature on the Indonesian rivers Solo and Porong dispersal systems suggests that those systems may, at different times, be subject to processes similar to those which operate off the mouths of the Huanghe, Purari and Jaba although no single, direct analogies can be made. (Author's abstract)
W90-03488

PATTERN ANALYSIS OF ORGANIC COMPONENT ABUNDANCES FROM DELTAIC AND OPEN MARINE DEPOSITS: PALYNOFACIES DISTRIBUTION (EAST JAVA, INDONESIA).
Utrecht Rijksuniversiteit (Netherlands). Lab. of Palaeobotany and Palynology.
For primary bibliographic entry see Field 2L.
W90-03489

BUOYANT RIVER PLUMES AND MUD DEPOSITION IN A RAPIDLY EXTENDING TROPICAL DELTA.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
P. Hoekstra.
Netherlands Journal of Sea Research NJSRBA, Vol. 23, No. 4, p 517-527, August 1989. 9 fig, 2 tab, 10 ref.

Descriptors: *Indonesia, *Java, *Sediment transport, *River flow, *Sedimentation, *Deltas, Monsoonal river, Solo River, Seasonal variation, Model studies, Simulation analysis, Sediment distribution.

The Solo river, East Java, Indonesia, is a typical monsoonal river. The major part of river discharge and sediment transport is realized during the four or five months of the wet season. River outflow essentially has the character of a buoyant jet. The buoyancy of the effluents gives rise to the development of buoyant river plumes. The properties and behavior of these plumes are of fundamental importance in the depositional processes which govern delta growth. Deposition rates near the river mouth have been calculated by modelling river outflow and plume dimensions. Simulations of 'banjir' events (periods of high discharge) suggest that the average, areal deposition may range from 1 to 10 cm/d. The estimated annual changes

in bed level exceed values of 1.0 m, even if consolidation is taken into account. Measured changes in bed level, as deducted from echosoundings, show good agreement with model calculations. (Author's abstract)
W90-03492

SUPPLY AND DISPERSION OF WATER AND SUSPENDED MATTER OF THE RIVERS SOLO AND BRANTAS INTO THE COASTAL WATERS OF EAST JAVA, INDONESIA.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
P. Hoekstra, R. F. Nolting, and H. A. Van Der Sloot.
Netherlands Journal of Sea Research NJSRBA, Vol. 23, No. 4, p 501-515, August 1989. 9 fig, 3 tab, 8 ref.

Descriptors: *Indonesia, *Java, *Sediment transport, *Sediment distribution, Seasonal variation, Flow pattern, Brantas River, Solo River, Bed load, Estuaries.

Major elements and a trace metal have been used to trace the fate and origin of water and suspended matter (SPM) of the river Solo and Brantas into the coastal water of East Java. The transport, dispersion and distribution of water and SPM definitely have a seasonal character and are principally wet-season phenomena. In that season, monsoon and tide-induced coastal currents result in eastward fluxes of water and SPM. These longshore fluxes along the northern coastline of Java and Madura almost completely reduce the transport in an offshore direction (Java Sea). In the Strait of Surabaya, the amount of SPM from the Solo river clearly exceeds the contribution of the Brantas system. Both flow patterns and the magnitude of supply--the Solo is a suspension-load river--are responsible for this dominance. In the Porong delta, there is little exchange of estuarine SPM. In the dry season, estuarine mixing processes operate in the lower parts of the deltas, modifying the chemical characteristics of the water masses and SPM. The SPM of the Solo river again represents the largest share in the total amount of SPM. In the Strait of Surabaya, resuspension of particles originating from the Solo delta is the major process that determines the presence of SPM. (Author's abstract)
W90-03493

USE OF CESIUM-137 MEASUREMENTS TO INVESTIGATE EROSION AND SEDIMENT SOURCES WITHIN A SMALL DRAINAGE BASIN IN THE LOESS PLATEAU OF CHINA.
Chengdu Inst. of Mountain Disaster and Environment (China).
X. Zhang, S. Li, C. Wang, W. Tan, and Q. Zhao.
Hydrological Processes HYPRE3, Vol. 3, No. 4, p. 317-323, October-December 1989. 3 fig, 1 tab, 6 ref.

Descriptors: *Tracers, *Soil erosion, *Erosion, *Sediment erosion, *Radioactive tracers, *Cesium radioisotopes, *China, Rill erosion, Sheet erosion, Gully erosion, Slopes, Cultivated lands, Floods.

The contributions of sediment from different geomorphological units within a small basin in the Loess Plateau have been determined using cesium-137 as a tracer. The mean cesium-137 content of sediment originating from the hill area, where sheet and rill erosion are predominant, was 3.37 Bq/kg, whereas no cesium-137 was detected in the sediment originating from the gully area where gullying and gravitational erosion are predominant. The mean cesium-137 content of sediment from two flood deposits was 0.23 Bq/kg and 0.89 Bq/kg. The relative contribution from the hill area in the two floods was 7% and 26%, while that from the gully area was 93% and 74%. These results indicate that the sheet and rill erosion associated with cultivated land in the hill area and that gullying and gravitational erosion in the gully area are both very severe. (Peters-PTT)
W90-03500

TRANSPORT OF HEAVY METALS DURING FLOOD EVENTS IN THE POLLUTED RIVER GEUL (THE NETHERLANDS).
Utrecht Rijksuniversiteit (Netherlands).
For primary bibliographic entry see Field 5B.
W90-03501

SEDIMENT DEPOSITION IN CUTOFF MEANDER BENDS AND IMPLICATIONS FOR EFFECTIVE MANAGEMENT.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
F. D. Shields, and S. R. Abt.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 4, p. 381-396, November-December 1989. 9 fig, 3 tab, 37 ref.

Descriptors: *Sedimentation, *Sediment transport, *Cutoffs, *Sediment control, *Regulated flow, *Model studies, Backwater, Discharge capacity, Suspended sediments, Bed load, Construction, Mississippi River, Arkansas River.

Cutoff bends along modified, stabilized streams often constitute a valuable recreational, ecological, and aesthetic resource. However, their resource value rapidly declines as they fill with sediment, and new cutoff bends do not form to replace them in highly managed rivers. Data from repetitive hydrographic surveys of 20 cutoff bends along four rivers in the southeastern United States were examined using conceptual and analytical models in order to provide a more objective basis for bend management. Bend volume was found to be a log-decay function of cumulative water discharge through the cutoff reach. Regression analyses were used to generate functions to predict the log-decay constant. The log-decay constant varied directly with master stream suspended bed-material concentration and inversely with variables describing the geometry of the upstream entrance of the old bend. Management of cutoff bends should focus on sequencing construction activities and modification of the upstream bend entrance geometry to reduce the quantity of bed material diverted into the bend. Construction of blockage structures to top-bank elevation in upstream entrances of cutoff bends is recommended for systems with average suspended bed-material concentrations greater than about 50 ppm. Blockage or modification of entrance geometry of longer bends preserves more aquatic habitat longer than similar levels of effort directed toward shorter bends. Maintenance of a hydraulic connection between the river and at least one end of the cutoff bend is recommended. (Author's abstract)
W90-03511

2K. Chemical Processes

MODELING THE TRANSPORT OF SOLUTES INFLUENCED BY MULTIPROCESS NONEQUILIBRIUM.
Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 2F.
W90-02586

HISTORICAL RECONSTRUCTIONS AND FUTURE FORECASTS OF REGIONAL SURFACE WATER ACIDIFICATION IN SOUTHERNMOST NORWAY.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W90-02589

METAL CONTENT IN SESTON FROM THE SAN JOSE GULF, PATAGONIA, ARGENTINA.
Centro Nacional Patagonico, Chubut (Argentina).
For primary bibliographic entry see Field 2L.
W90-02627

APPLICATIONS OF INTERVENTION ANALYSIS TO MODEL THE IMPACT OF DROUGHT AND BUSHFIRES ON WATER QUALITY.
Rural Water Commission of Victoria, Armadale (Australia). Water Quality Assessment Section.
For primary bibliographic entry see Field 7C.

W90-02649

ORGANIC GEOCHEMICAL ANALYSIS OF TERRESTRIAL BIOMARKERS IN A TRANSECT OF THE GREAT BARRIER REEF LAGOON.
Melbourne Univ., Parkville (Australia). Dept. of Organic Chemistry.
For primary bibliographic entry see Field 2L.
W90-02650

INFLUENCE OF TREE CANOPIES ON THE QUANTITY OF WATER AND AMOUNT OF CHEMICAL ELEMENTS REACHING THE PEAT SURFACE OF A BASIN MIRE IN THE MIDLANDS OF ENGLAND.
Nottingham Univ. (England). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W90-02668

MEASUREMENT OF REAERATION IN STREAMS: COMPARISON OF TECHNIQUES.
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W90-02722

UNIQUE LIMNOLOGICAL PHENOMENA AFFECTING WATER QUALITY OF HAMILTON HARBOUR, LAKE ONTARIO.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 5B.
W90-02758

EVIDENCE FOR A NEW PATHWAY IN THE BACTERIAL DEGRADATION OF 4-FLUORO-BENZOATE.
Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Mikrobiologie.
For primary bibliographic entry see Field 5B.
W90-02784

REDUCTIVE DEHALOGENATION OF DICHLOROANILINES BY ANAEROBIC MICROORGANISMS IN FRESH AND DICHLORO-PHENOL-ACCLIMATED POND SEDIMENT.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5B.
W90-02785

MICROBIAL DEGRADATION OF SEVEN AMIDES BY SUSPENDED BACTERIAL POPULATIONS.
Environmental Protection Agency, Athens, GA. Southeast Environmental Research Lab.
For primary bibliographic entry see Field 5B.
W90-02787

HUMIC MATTER ISOLATED FROM SOILS AND WATER BY THE XAD-8 RESIN AND CONVENTIONAL NAOH METHODS.
Georgia Univ., Athens. Dept. of Agronomy.
J. C. Lobartini, K. H. Tan, L. E. Asmussen, R. A. Leonard, and D. Himmelsbach.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 20, No. 13-14, p 1453-1477, Aug 1989. 7 fig, 3 tab, 29 ref.

Descriptors: *Fulvic acids, *Separation techniques, *Water analysis, *Humic acids, *Decomposing organic matter, *Soil analysis, Streams, Spectroscopy, Infrared spectroscopy, Electron microscopy, Nuclear magnetic resonance, Chemical analysis, Resins, Adsorption methods, Soil chemistry.

The most widely used reagent for the extraction and isolation of humic matter from soils is a weak solution of NaOH. However, humic compounds extracted from streams using amberlite resin adsorption are believed to be more representative than those isolated by the standard NaOH extraction procedure for soils. This research was con-

ducted to study characteristic differences in humic (HA) and fulvic acid (FA) extracted from soils and streams in South Georgia using the Amberlite XAD-8 resin and the conventional NaOH method. Characterization analysis was performed by liquid C13 NMR, infrared (IR) spectroscopy, scanning electron microscopy (SEM), and chemical analysis. The NMR spectra indicated that the resin method yielded black water HA and FA with spectroscopic, chemical and elemental characteristics different from those isolated by the conventional NaOH method. Humic acids from both the resin and conventional NaOH methods were composed of aliphatic, aromatic and carboxyl groups, but the 'resin' HA contained more aliphatic groups. These differences were also noticed between the FA fractions obtained by the two methods. The differences corresponded to differences in IR spectra. Fulvic acid extracted by the resin method was also higher in total acidity, but considerably lower in N content than FA obtained by the conventional NaOH method. Both methods yielded black water FA which was less aromatic in nature than black water HA, or soil FA. (Author's abstract)
W90-02836

WATER QUALITY AND SUPPLY, CORTINA RANCHERIA, COLUSA COUNTY, CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-02850

NATURAL GROUND-WATER QUALITY IN MICHIGAN: 1974-87.
Geological Survey, Lansing, MI. Water Resources Div.
T. R. Cummings.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-259, 1989. 50p, 15 fig, 5 tab, 23 ref.

Descriptors: *Water quality, *Geohydrology, *Geochemistry, *Michigan, Groundwater, Data collections, Water resources data.

Wide variations occur in the chemical and physical characteristics of natural groundwaters in Michigan. Dissolved-solids concentrations range from 20 to 76,000 mg/L. Waters having low dissolved-solids concentrations are calcium bicarbonate-type waters. Sodium, sulfate, and chloride increase as mineralization increases. Iron, aluminum, and titanium concentrations are higher at some locations than is common in most natural waters. Lead concentrations exceed U.S. Environmental Protection Agency's primary drinking-water regulations at some locations in the northern part of the lower Peninsula. Generalized areal patterns of water-quality variability indicate that geology is a primary cause of differences across the State. Examples of chemical associations in water indicate that chemical analyses may be valuable in tracing and identifying mineral deposits. (USGS)
W90-02864

GROUND WATER AND CLASTIC DIAGENESIS.
Alberta Univ., Edmonton. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-02910

ROLE OF GROUND-WATER PROCESSES IN THE FORMATION OF ORE DEPOSITS.
Texas Univ. at Austin. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2F.
W90-02913

HYDROCHEMICAL FACIES AS HYDRAULIC BOUNDARIES IN KARSTIC AQUIFERS--THE EDWARDS AQUIFER, CENTRAL TEXAS, U.S.A.
Texas Univ. at Austin. Dept. of Geological Sciences.

For primary bibliographic entry see Field 2F.
W90-03141

FLUORITE SATURATION AND EQUILIBRIUM TRENDS IN THE GROUNDWATER SYSTEM FROM THE KARST PLAINS OF SOUTHERN INDIANA, USA.
Ibadan Univ. (Nigeria). Hydro/Engineering Geology Unit.
For primary bibliographic entry see Field 2F.
W90-03142

GEOCHEMISTRY OF SOME SULPHATE GROUND WATERS IN RELATION WITH GYPSUM KARST (ALMERIA, SOUTHEASTERN SPAIN).
Granada Univ. (Spain). Dept. of Geodynamic.
For primary bibliographic entry see Field 2F.
W90-03146

B, F AND SR AS TRACERS IN CARBONATE AQUIFERS AND IN KARSTIC GEOTHERMAL SYSTEMS IN ISRAEL.
Geological Survey of Israel, Jerusalem.
For primary bibliographic entry see Field 2F.
W90-03152

OCCURRENCE OF WATER QUALITY REGIME TYPES DURING THE EXPLOITATION OF KARST WATER RESOURCES IN COASTAL REGIONS AND THE MECHANISM OF THEIR FORMATION.
The No. 1 Hydrogeology and Engineering Geology Party of Liaoning Province, China.
For primary bibliographic entry see Field 2F.
W90-03165

INTERACTIONS BETWEEN PB-ZN MINE OF GUTTURU PALA AND LOCAL GROUNDWATER RESOURCES (FLUMINESE, SARDINIA, ITALY).
Dept. Georisorse e Territorio, Torino, Italy.
For primary bibliographic entry see Field 4C.
W90-03172

TURNOVER OF EXTRACELLULAR DNA IN EUTROPHIC AND OLIGOTROPHIC FRESHWATER ENVIRONMENTS OF SOUTHWEST FLORIDA.
University of South Florida, St. Petersburg. Dept. of Marine Science.
For primary bibliographic entry see Field 2H.
W90-03236

ANNUAL PATTERNS OF DENITRIFICATION AND NITRATE AMMONIFICATION IN ESTUARINE SEDIMENT.
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.
For primary bibliographic entry see Field 2L.
W90-03237

SPATIAL AND TEMPORAL VARIATION OF WATER COLUMN MEASUREMENTS IN AQUACULTURE PONDS.
Hawaii Univ., Honolulu. Dept. of Oceanography.
For primary bibliographic entry see Field 7B.
W90-03239

FORMS AND HYDROLYTIC BEHAVIOR OF SULPHUR IN HUMIC ACID AND RESIDUE FRACTIONS OF FOUR PEATS FROM THE FRASER LOWLAND.
British Columbia Univ., Vancouver. Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W90-03289

EFFECTS OF CROPPING ON CARBOHYDRATE CONTENT AND WATER-STABLE AGGREGATION OF A CLAY SOIL.
Agriculture Canada, Sainte-Foy (Quebec). Research Station.

For primary bibliographic entry see Field 2G.
W90-03290

ACID-PERSULFATE DIGESTION PROCEDURE FOR DETERMINATION OF PHOSPHORUS IN SEDIMENTS.
Southern Forest Experiment Station, Oxford, MS. Forest Hydrology Lab.
For primary bibliographic entry see Field 7B.
W90-03291

DIFFUSION OF AMMONIUM AND NITRATE IONS IN FLOODED SOIL AND NITROGEN USE EFFICIENCY OF AN IRRIGATED RICE SYSTEM.
Ministry of Food, Agriculture and Co-operatives, Islamabad (Pakistan).
For primary bibliographic entry see Field 2G.
W90-03293

RELATIONSHIP BETWEEN WATER SOLUBLE AND EXCHANGEABLE SOIL CATIONS FOR ESTIMATING PLANT UPTAKE AND LEACHING POTENTIAL.
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
For primary bibliographic entry see Field 2G.
W90-03297

EFFECT OF TWO SOIL MOISTURE LEVELS AND WETTING-DRYING CYCLES ON MANGANESE RELEASE IN NACL-AMENDED SOILS.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 2G.
W90-03302

GROWTH RESPONSE AND MINERAL UPTAKE OF VEGETABLE TRANSPLANTS GROWN IN A COMPOSTED SEWAGE SLUDGE AMENDED MEDIUM. I. NUTRIENT SUPPLYING POWER OF THE MEDIUM.
Maryland Univ., College Park. Dept. of Horticulture.
For primary bibliographic entry see Field 5E.
W90-03311

GROWTH RESPONSE AND MINERAL UPTAKE OF VEGETABLE TRANSPLANTS GROWING IN COMPOSTED SEWAGE SLUDGE AMENDED MEDIUM. II. INFLUENCED BY TIME OF APPLICATION OF N AND K.
Maryland Univ., College Park. Dept. of Horticulture.
For primary bibliographic entry see Field 5E.
W90-03312

GROWTH RESPONSE AND MINERAL UPTAKE OF LETTUCE AND TOMATO TRANSPLANTS GROWN IN MEDIA AMENDED WITH COMPOSTED SEWAGE SLUDGE.
Maryland Univ., College Park. Dept. of Horticulture.
For primary bibliographic entry see Field 5E.
W90-03313

INTERSTITIAL AND ION-EXCHANGE WATER IN THE NORTHERN BORDER OF THE BAVARIAN CALCAREOUS ALPS.
Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl fuer Hydrogeologie und Hydrochemie.
For primary bibliographic entry see Field 2F.
W90-03355

DETERMINATION OF DISSOLVED OXYGEN BY PHASE-BOUNDARY-TRANSMISSION--A POSSIBILITY TO ELIMINATE INTERFERENCES CAUSED BY SUBSTANCES IN WATER.
Technische Univ. Berlin (Germany, F.R.). Inst. fuer Technischen Umweltschutz.
For primary bibliographic entry see Field 7B.

W90-03358

**CATION TYPE AND IONIC STRENGTH EF-
FECTS ON THE SOLUTION COMPOSITION
OF AN ACIDIC SUBSOIL.**
Department of Agriculture and Water Supply, Pie-
termaritzburg (South Africa). Natal Region.
For primary bibliographic entry see Field 2G.
W90-03412

**INVESTIGATION OF CORRELATION BE-
TWEEN PHYSICOCHEMICAL PROPERTIES
OF METALS AND THEIR TOXICITY TO THE
WATER FLEA DAPHNIA MAGNA STRAUS.**
Industrial Toxicology Research Centre, Lucknow
(India).
For primary bibliographic entry see Field 5C.
W90-03434

**TRANSPORT OF RIVER-DERIVED TRACE
METALS THROUGH THE COASTAL ZONE.**
Bedford Inst. of Oceanography, Dartmouth (Nova
Scotia). Marine Chemistry Div.
For primary bibliographic entry see Field 5B.
W90-03481

**INPUT OF SELECTED CHLORINATED HY-
DROCARBONS INTO THE COASTAL AREA
OF EAST JAVA AND ADJACENT WATERS:
DISTRIBUTION PATTERNS IN THE DIS-
SOLVED AND SUSPENDED PHASE.**
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 5B.
W90-03482

**TRACE OXYANIONS AND THEIR BEHAVIOR
IN THE RIVERS PORONG AND SOLO, THE
JAVA SEA AND THE ADJACENT INDIAN
OCEAN.**
Netherlands Energy Research Foundation ECN,
Petten.
For primary bibliographic entry see Field 5B.
W90-03483

**DISTRIBUTION OF DISSOLVED AND PAR-
TICULATE MINOR AND MAJOR ELEMENTS
IN THE RIVER AND COASTAL ENVIRON-
MENT OF EAST JAVA DURING THE SNEL-
LIUS-II EXPEDITION.**
Nederlands Inst. voor Onderzoek der Zee, Texel.
R. F. Nolting, H. Hutagalung, and D. Moelyadi
Moelyo.
Netherlands Journal of Sea Research NJSRBA,
Vol. 23, No. 4, p 387-402, August 1989. 10 fig, 4
tab, 38 ref.

Descriptors: *Geochemistry, *Indonesia, *Java,
*Heavy metals, *Trace elements, Copper, Zinc,
Cadmium, Nickel, Lead, Iron, Chromium, Silicon,
Calcium, Magnesium, Manganese, Potassium, Sea-
sonal variation, Suspended solids, Distribution,
River systems, Path of pollutants, Water pollution
sources, Estuaries, Coastal waters.

The concentration and distribution of dissolved
Cu, Zn, Cd, Ni, Pb and Fe, and Cu, Zn, Cd, Ni,
Pb, Cr, Fe, Si, Ca, Mg, Mn, and K in suspended
matter have been determined in the rivers Porong
and Solo and in Strait Madura (East Java), during
the dry-monsoon and wet-monsoon periods. Based
on element/Al ratios, the suspended matter sup-
plied by each of the two rivers can be traced
offshore. The main source of material supplied to
the coastal area is the Solo river. The distribution
of the trace-metal content in suspended matter
collected in the rivers can be described as a mix-
ture of metal-rich, organic-rich particles and a
metal-poor, detrital fraction. Due to the presence
of mud barriers at the river mouths, particles with
high trace elements contents are trapped in the
estuaries. Compared to European rivers the dis-
solved trace metal concentrations in these rivers
are relatively low. The dissolved concentrations of
the different trace elements in Strait Madura show
no uniform distribution pattern during the two
sampling periods. (Author's abstract)
W90-03484

**HEAVY METALS (CU, ZN, CD, PB) IN SEDI-
MENT OF THE JAVA SEA, ESTUARINE AND
COASTAL AREAS OF EAST JAVA AND SOME
DEEP-SEA AREAS.**
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 5B.
W90-03485

**COPPER, ZINC AND CADMIUM IN BENTHIC
ORGANISMS FROM THE JAVA SEA AND ES-
TUARINE AND COASTAL AREAS AROUND
EAST JAVA.**
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 5B.
W90-03486

**PREDICTION OF AQUATIC SEDIMENT-AS-
SOCIATED TRACE ELEMENT CONCENTRA-
TIONS USING SELECTED GEOCHEMICAL
FACTORS.**
Geological Survey, Doraville, GA.
A. J. Horowitz, K. A. Elrick, and R. P. Hooper.
Hydrological Processes HYPRE3, Vol. 3, No. 4, p
347-364, October-December 1989. 2 fig, 4 tab, 44
ref.

Descriptors: *Trace elements, *Heavy metals,
*Sediment chemistry, *Model studies, *Geochem-
istry, Fluvial sediments, Lake sediments, Continen-
tal shelf, Regression analysis, Copper, Zinc, Lead,
Chromium, Nickel, Cobalt, Arsenic, Tin, Seleni-
um, Mercury.

Multiple linear regression models calculated from
readily obtainable chemical and physical param-
eters can explain a high percentage (70% or great-
er) of observed sediment-trace element variance
for Cu, Zn, Pb, Cr, Ni, Co, As, Sb, Se, and Hg in a
widely divergent suite of 61 sediment samples
taken from rivers, lakes and the continental shelf of
the United States that were presumed to be chemi-
cally unaffected by anthropogenic sources. The
independent variables used in the models could be
single parameters, principal component scores, or
principal component scores combined with their
cross-productions. The most useful type of variable
must be determined on a case-by-case basis. The
independent variables (geochemical parameters) in-
corporated in the models calculated during the
study probably are applicable to many aquatic
sediments; use of a larger data set (>61) could
alter the magnitude of the calculated coefficients.
The geochemical parameters included in the
models were of a physical (e.g. grain size, surface
area) and a chemical (e.g. organic matter, amor-
phous iron oxides) nature. Comparison between
actual and predicted trace element concentrations
obtained from the models may provide a means of
defining 'average' sediment-trace element concen-
trations. The models may also help identify either
naturally or anthropogenically impacted sites for
additional study. (Peters-PTT)
W90-03503

**SIMULATED WATER-LEVEL AND WATER-
QUALITY CHANGES IN THE BOLSON-FILL
AQUIFER, POST HEADQUARTERS AREA,
WHITE SANDS MISSILE RANGE, NEW
MEXICO.**
Geological Survey, Albuquerque, NM. Water Re-
sources Div.
For primary bibliographic entry see Field 2F.
W90-03545

ACID RAIN IN PUERTO RICO.
Puerto Rico Univ., Mayaguez. Engineering Re-
search Center.
For primary bibliographic entry see Field 5A.
W90-03557

2L. Estuaries

**IMPLEMENTATION OF THE THREE-DIMEN-
SIONAL HYDRODYNAMIC MODEL FOR THE
ARABIAN GULF.**
University of Petroleum and Minerals, Dhahran
(Saudi Arabia). Water Resources and Environment

Div.
R. W. Lardner, A. H. Al-Rabeh, N. Gunay, and H.
M. Cekirge.
Advances in Water Resources AWREDI, Vol. 12,
No.1, p 2-8, March 1989. 5 fig, 17 ref.

Descriptors: *Persian Gulf, *Paleohydrology,
*Hydrodynamics, *Tidal hydraulics, *Hydraulic
models, *Water currents, *Model studies, Wind-
driven currents, Tidal currents, Shallow water,
Vertical flow, Water level, Dimensional analysis,
Storm surges, Algorithms, Surface velocity, Saudi
Arabia, Coastal zone management.

There is an abundance of literature on hydrody-
namic models for tidal flows and storm surges for
various sea regions. Many of these models are
based on two-dimensional shallow-water equa-
tions. Such models are only useful when knowl-
edge about the vertical flow structure is not re-
quired. Recently, several models have been devel-
oped to predict currents at all water levels. A
three-dimensional hydrodynamic model for tidal
and wind-driven currents for application to the
Persian Gulf has been developed. Appropriate
values were selected for the hydrodynamical pa-
rameters, using available oceanographic measure-
ments (winds, tides, residual effects) in the Persian
Gulf. The Persian Gulf was covered by a coarse
grid block (grid-spacing 20 kilometers) and the
coastal area of Saudi Arabia was covered by a fine
grid block (grid-spacing 5 kilometers). An interpo-
lation algorithm was developed to compute surface
current velocity profiles at off grid points. (Fish-
PTT)
W90-02545

**COMPARISON OF STATE CONSTRUCTION
SETBACKS TO MANAGE DEVELOPMENT IN
COASTAL HAZARD AREAS.**
National Oceanic and Atmospheric Administra-
tion, Washington, DC. Office of Ocean and Coast-
al Resource Management.
For primary bibliographic entry see Field 4A.
W90-02551

**CONSEQUENCES OF SEA LEVEL RISE: IM-
PLICATIONS FROM THE MISSISSIPPI
DELTA.**
Louisiana State Univ., Baton Rouge. Center for
Wetland Resources.
J. W. Day, and P. H. Templet.
Coastal Management CZMJBF, Vol. 17, No. 3, p
241-257, 1989. 1 fig, 3 tab, 58 ref.

Descriptors: *Sea level, *Water resources develop-
ment, *Coastal zone management, *Wetlands,
*Deltas, Sedimentation rates, Vegetation effects,
Saline water intrusion, Roots, Soil genesis, Flood
control, Dikes, Control systems, Long-term plan-
ning, Ecological effects, Environmental engineer-
ing, Growth rates, Mississippi.

Historically, the Mississippi River Delta has expe-
rienced a relative sea level rise (RSLR) and thus
serves as an analogy or model for what can be
expected elsewhere. Within this century, the net
positive growth rate has been reversed and net
wetlands loss rate as great as 100 sq km/yr have
occurred. Much of the wetland loss is associated
with human activities that have resulted in a reduc-
tion of sediment input to wetlands. Because of this
reduction, vertical accretion of the wetland surface
is less than RSLR and plants are disappearing due
to waterlogging and salinity increase. The resulting
loss of wetland plant vigor complicates the prob-
lem because the production of plant roots is an
important component of soil formation and vertical
accretion of the wetland surface. A common re-
sponse to rising water levels will be flood control.
But in the Mississippi Delta, dikes along the river
have greatly restricted sediment input to wetlands.
Additionally, semi-impoundments with water con-
trol structures are being considered to protect wet-
lands from increasing water levels and salinity
increases. Coastal wetlands can be managed to
survive rising sea level, but only comprehensive,
integrated, long-term planning can effectively deal
with the problem of sea level rise. The principle of
ecological engineering should play an integral part

of any management plan. Because deltas are probably one of the most threatened of coastal landscapes, an early warning monitoring system is recommended for selected deltas of the world. (Author's abstract)
W90-02552

WHAT HAPPENED TWENTY YEARS AFTER THE GRANDE MOTTE MARINA BUILDING ENDED (LA GRANDE MOTTE, VINGT ANS APRES).
Laboratoire National d'Hydraulique, Chatou (France).
For primary bibliographic entry see Field 6B.
W90-02555

DEPOSITIONAL EVOLUTION OF A WIND-WARD, HIGH-ENERGY LAGOON, GRAHAM'S HARBOR, SAN SALVADOR, BAHAMAS.
Miami Univ., Oxford, OH. Dept. of Geology.
N. D. Colby, and M. R. Boardman.
Journal of Sedimentary Petrology JSEPAK, Vol. 59, No. 5, p 819-834, September 1989. 14 fig, 1 tab, 69 ref.

Descriptors: *Sedimentation, *Stratigraphy, *Paleohydrology, *Carbonates, *Lagoons, *Deposition, *Bahamas, *Marine sediments, Vertical distribution, Temporal distribution, Sediment transport, Bathymetry, Mud, Geological surveys, Sea level, Cores, Mineralogy, Sediment control, Benthic fauna, Benthic flora, Water currents, Waves, Sediment distribution, Water depth, Basins, Storms, Radioactive dating.

Studies of lagoonal carbonate deposition established broad facies relationships for large lagoons and laid the groundwork for much subsequent work on the many interrelated factors which control the lateral, vertical, and temporal distribution of lagoonal facies. Sediment probes and bathymetric surveys have been performed in Graham's Harbor, San Salvador, Bahamas. Surface samples and sediment cores have been evaluated with respect to texture, composition, and mud fraction mineralogy, revealing four marine facies which are distributed vertically and laterally in a well-defined, non-random pattern within the lagoon and reflect control of deposition by benthic communities and modification by transport resulting from waves and currents. Three surficial facies are found which suggest that the primary controls of lateral distribution are benthic flora and energy of waves and currents. Water depth does not appear to effect lateral facies distribution. Studies of sediment cores reveal a coarsening-upwards sedimentary sequence, suggesting initial deposition within a silled basin comprised of lower-energy, normal marine, muddy sediments. Aggregates in this facies were probably transported from the west during storms. As sea level rose above the sill, less muddy, higher-energy sediments were deposited. Radiocarbon dates of peat and sediment from cores indicate that the entire carbonate sequence formed in less than 7,000 years at rates of 27-95 cm/1,000 years. (Fish-PTT)
W90-02581

POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS IN SELECTED ESTUARINE SEDIMENTS.
Environmental Protection Agency, Narragansett, RI. Environmental Research Lab.
For primary bibliographic entry see Field 5B.
W90-02604

METAL CONTENT IN SESTON FROM THE SAN JOSE GULF, PATAGONIA, ARGENTINA.
Centro Nacional Patagonico, Chubut (Argentina).
M. N. Gil, V. Sastre, N. Santinelli, and J. L. Esteves.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 3, p 337-341, 1989. 1 fig, 2 tab, 5 ref. SECYT grant 135-1595/84.

Descriptors: *Baseline studies, *Water analysis, *San Jose Gulf, *Water chemistry, *Heavy metals, *Zooplankton, *Plankton, *Food chains, Ecosystems, Iron, Zinc, Manganese, Copper, Cadmium,

Lead, Nickel, Argentina, Diatoms, Absorption, Bioaccumulation, Data acquisition.

Plankton are capable of concentrating large quantities of heavy metals from seawater, and this provides an entry into the marine food web. Baseline levels of Fe, Zn, Mn, Cu, Cd, Pb and Ni were determined in seston from the San Jose Gulf, Argentina which is in a semiarid area of Argentina having no human-industrial settlement on its coast. The San Jose Gulf is not affected by influx from rivers, rainwater, or sewage outfalls. Diatoms were generally the major fraction of the seston collected, with a wide variety of species represented, including Coscinodiscus sp., Gyrosiqma sp., and Pleurosigma strigosum. The dry weight trace metal concentrations, in ppm, over six samplings between December 1985 and December 1986, ranged from: Fe, 721-2037; Zn, 145-600; Mn, 948-16,116; Cu, 30-93; Cd, 12-54; Pb, 43-22; and Ni, none detected. (Friedmann-PTT)
W90-02627

ROLE OF SEDIMENTS IN THE DISTRIBUTION OF UCA PUGILATOR (BOSC) AND UCA PUGNAX (SMITH) (CRUSTACEA, BRACHYURA) IN A SALT MARSH OF CAPE COD.
Universidad Austral de Chile, Valdivia. Inst. de Zoologia.
For primary bibliographic entry see Field 2H.
W90-02645

WINTER STUDY OF PLANKTON DISTRIBUTION ACROSS A COASTAL SALINITY FRONT IN THE GERMAN BIGHT.
Alfred-Wegener-Inst. fuer Polarforschung, Bremerhaven (Germany, F.R.).
K.-J. Hesse, D. Gerdes, and K. Schaumann.
Meeresforschung MEERDW, Vol. 32, No. 3, p 177-191, August 1989. 10 fig, 28 ref.

Descriptors: *Ecology, *Salinity, *Coastal waters, *Fungi, *Zooplankton, *Phytoplankton, Hydrodynamics, Saline-freshwater interfaces, Elbe River, West Germany, North Sea, River mouth.

Freshwater input into the German Bight deriving mainly from the Elbe River gives rise to well-defined salinity fronts. The quantitative and qualitative distribution of phyto-, myco-, and zooplankton during late winter was closely related to the frontal structures. Composition of plankton populations changed across the front, confirming that the front acts as a retention barrier for distinct plankton communities. In the fresher coastal water, strongly influenced by the discharge of the Elbe River, tychopelagic diatoms, brackish water fungi and larvae of polychaeta and cirripedia dominated, whereas holopelagic phytoplankters, halophilic fungi (especially among the yeasts and phycomycetes) and copepods dominated at the seaward side of the front. Phytoplankton standing stock was twice as high in the coastal water than in the offshore water, due more to advection of tychopelagic cells from a turbulent nearshore site of growth than to local in situ production. A slight but distinct frontal phytoplankton maximum at the coastal side of the front was associated with a maximum in silt-content and is therefore interpreted as a result of passive accumulation. No parallel zooplankton accumulation could be demonstrated which stresses the dominant role of biological factors in frontal zooplankton aggregations. The mycoplankton exhibited an accumulation at the front only during early ebb-tide; with continuing ebb-tide a more or less homogeneous distribution across the front was observed. Hydrodynamic as well as biological effects are assumed to be responsible for the specific mycoplankton distribution and accumulation patterns. (Author's abstract)
W90-02646

NITROGEN FIXATION (ACETYLENE REDUCTION) IN NONHETEROCYSTOUS CYANOBACTERIAL MATS FROM THE DAMPIER ARCHIPELAGO, WESTERN AUSTRALIA.
Western Australia Univ., Nedlands. Dept. of Botany.
E. I. Paling, A. J. McComb, and J. S. Pate.
Australian Journal of Marine and Freshwater Re-

search AJMFA4, Vol. 40, No. 2, p 147-153, 1989. 4 fig, 27 ref.

Descriptors: *Cyanophyta, *Chlorophyll a, *Intertidal areas, *Acetylene reduction, *Nitrogen fixation, Salinity, Dampier Archipelago, Australia.

Discs punched from non-heterocystous cyanobacterial mats inthe Dampier Archipelago, Western Australia, , one containing Microcoleus chthonoplastes, Oscillatoria and Phormidium species. the other Phormidium and Aphanocapsa species, were incubated for 23 days in artificial seawater of salinity 0 to 140 gm/L. The chlorophyll a content of both mats increased over this salinity range, with lower increases above 100 gm/L. There was little change in the species composition of mats at salinities < or = 40 gm/L; < 40 gm/L, mats produced essentially monospecific thalli containing small quantities of the other species. Acetylene reduction ranged from zero at the highest salinity to a maximum of 1100-1500 micromoles C2H2 reduced/ sq m/h at 20-60 gm/L. Maximum fixation rates were two orders of magnitude higher than in situ measurements (8-60, mean 16 micromole C2H2 reduced/sq m/h). The salinity range observed in the field was 40-60 gm/L, but maximum fixation rates in the field (60 micromoles C2H2 reduced/sq m/h) were much lower than those observed in the laboratory. (Author's abstract)
W90-02648

ORGANIC GEOCHEMICAL ANALYSIS OF TERRESTRIAL BIOMARKERS IN A TRANSECT OF THE GREAT BARRIER REEF LAGOON.
Melbourne Univ., Parkville (Australia). Dept. of Organic Chemistry.
B. R. Currie, and R. B. Johns.
Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 40, No. 3, p 275-284, 1989. 2 fig, 7 tab, 40 ref.

Descriptors: *Bioindicators, *Organic matter, *Coastal areas, Vegetation, Great Barrier Reef, Australia, Sediments, Sediment distribution.

Organic geomchemical analyses of benthic sediments from Northern Queensland coastal transect indicated that most terrestrial organic material is confined to near-shore sediments (less than 10 kilmoeters offshore). Traces of higher plant material reach the inner fringes of the Great Barrier Reef, as indicated by the presence of pentacyclic triterpenoid alcohols (PTA) in near-reef sediments. A likely source of these alcohols is mangroves. PTA and long-chain normal alkanes appear to be the most reliable of the lipid biomarker classes analized in assessing the distribution of terrestrial organic matter along the transect. Other terrestrial biomarker classes (sterols, normal fatty acids and fatty alcohols) present in the sediment do not show good correlation with distance from the land. This is believed to be due to the additional input of these biomarkers from planktonic sources.
W90-02650

RULE-BASED ECOLOGICAL MODEL FOR THE MANAGEMENT OF AN ESTUARINE LAKE.
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Computational and Applied Mathematics.
A. M. Starfield, B. P. Farm, and R. H. Taylor.
Ecological Modelling ECMODT, Vol. 46, No. 1/2, p 107-119, July 1989. 2 fig, 1 tab, 5 ref.

Descriptors: *Lake management, *Estuaries, *Model studies, *Ecological effects, *Coastal waters, *Lakes, Biomass, Biotic index, Salinity, Submerged plants, Biomass.

A rule-based model can be formulated and used to build a conventional dynamic model for an ecological system. The model assists managers of a large, shallow coastal lake connected to the sea by a narrow estuary. Fluctuations in the salinity of the lake have a marked effect on the biotic components and managers are interested in the likely effects of alternative strategies for ameliorating the

salinity. Available information lends itself to a representation in terms of rules that indicate how important biotic components change (on a crude scale of 1 to 5) depending on the prior state of the system and current water conditions. The abundance of underwater plant biomass is sensitive to the rate of change of salinity rather than the salinity level per se. This type of modeling draws on the experience of both scientists and non-scientists, provides a consistent, logical basis for discussion, improves communication between field biologists and managers, lends itself to an adaptive approach, and can provide assessments of the quality of each simulation. This approach is pertinent whenever the effects of abiotic events dominate mutual interactions between the biotic components of a system. (Author's abstract)
W90-02656

RESPONSE OF THREE MANGROVES TO SALINITY IN TWO GEOFORMS.
Instituto de Ecologia, A.C., Mexico City.
J. Lopez-Portillo, and E. Ezcurra.
Functional Ecology FECOE5, Vol. 3, No. 3, p 355-361, 1989. 4 fig, 2 tab, 23 ref.

Descriptors: *Mangrove swamps, *Salinity, Mud flats, Principal component analysis, Aquatic plants.

The variation in the physiognomy of the mangroves Avicennia germinans L., Rhizophora mangle L. and Laguncularia racemosa (L.) Gaertn., as related to salinity in two different geomorphic habitats (mudflats and interdistributary basins) was investigated. Due to the high intercorrelation between variables, principal component analysis was used to examine data on (1) water salinity on two sampling dates and in two geoforms, and (2) diameter at breast height, height and percent cover of each of the three species. The first component of each of these four data sets accounted for 77, 64, 90 and 93% of the total variance in the intervening variables. The projections of the intervening variables on their respective principal component was calculated, and response curves of species against environmental component scores were fitted by generalized linear models. The resulting curves were bell-shaped, except for A. germinans. The highest diversity and the maximum height and diameter for the three species is at low salinities and in interdistributary basins but the cover of A. germinans is higher in the mudflat and under high salinities. The range of response to environmental change is wider in A. germinans. A negative association between the cover of A. germinans and that of the other two species was noted, and the slope of the regression line suggests a substitution of one unit of cover of A. germinans by one unit of cover of any of the other two species in the interdistributary basins as salinity decreases. Results suggest that while abiotic environmental conditions may account for the absence of L. racemosa and R. mangle in the mudflats, biological interactions are more important in the formation of the mixed forests in the interdistributary basins. (Author's abstract)
W90-02661

POLLUTION AND TIDAL BENTHIC COMMUNITIES OF THE JAMES RIVER ESTUARY, VIRGINIA.
William and Mary Coll., Gloucester Point, VA. Inst. of Marine Science.
For primary bibliographic entry see Field 5C.
W90-02664

ROLE OF PLANKTON IN THE CARBON AND NITROGEN BUDGETS OF SANTA MONICA BASIN, CALIFORNIA.
Oregon State Univ., Corvallis. Coll. of Oceanography.
L. F. Small, M. R. Landry, R. W. Eppley, F. Azam, and A. F. Carlucci.
Marine Ecology Progress Series MESEDT, Vol. 56, No. 1-2, p 57-74, August 10, 1989. 8 fig, 7 tab, 44 ref. Dept of Energy contracts DE-FG05-85ER60340, DE-FG05-85ER60335 DE-FG05-88ER60628, DE-FG05-85ER60336, and DE-FG05-85ER60337.

Descriptors: *Cycling nutrients, *Santa Monica Bay, Carbon, Nitrogen compounds, Zooplankton, Bacteria, Primary productivity, Dissolved organic carbon.

The photic zone portions of a particle budget, resolved as carbon and, through appropriate carbon:nitrogen ratios, as nitrogen, are reported for the Santa Monica Bay, a 900 meter deep basin in Santa Monica Bay, within the Southern California Bight west of Los Angeles, California. Included are standing stocks of phytoplankton, bacteria and zooplankton, primary production, new production, and particle flux leaving the photic zone compared with rates of fecal pellet production by macrozooplankton and consumption by bacteria and zooplankton within the photic zone. Data from three October cruises and two spring cruises between 1985-1987 are used. Productivity and zooplankton measurements and some of the bacteria measurements were made above and within the nitracline. Comparison of carbon and nitrogen fluxes out of the photic zone with standing stocks of particulate carbon (PC) and particulate nitrogen (PN) indicated that PC had a shorter residence time than PN in the photic zone during both spring and fall. Conservation of nitrogen, relative to carbon, may be a general feature of oligotrophic surface waters, and is probably largely accomplished by preferential solubilization and assimilation of nitrogen by zooplankton and microheterotrophs. Increases in phytoplankton C:N ratios related to N-stress could be masked by relative increases in bacterial biomass with relatively low C:N composition ratios. Most of the primary production (either as C or N) was recycled within the photic zone, implying heavy grazing by organisms. Estimates of bacterial demand for DOC suggested that about half of the primary production was ultimately processed in the photic zone by bacteria. The transformations of PC by microheterotroph, and the ultimate partitioning of total PC flux into components due to direct settling of bacteria, phytoplankton, and detrital particles not processed by small herbivores, are unknown. (Author's abstract)
W90-02679

INFLUENCE OF LOCATION IN A SALT MARSH ON SURVIVORSHIP OF RIBBED MUSSELS.
North Carolina Univ. at Morehead City. Inst. of Marine Sciences.
J. Lin.
Marine Ecology Progress Series MESEDT, Vol. 56, No. 1-2, p 105-110, August 10, 1989. 2 fig, 1 tab, 39 ref.

Descriptors: *Limnology, *Marshes, *Wetlands, *Predation, *Mussels, *Salt marshes, Tidal effects, Crustaceans, Marsh plants, Estuaries.

The predation variation on ribbed mussels Geukensia demissa due to tidal elevation and distance into the salt marsh was assessed. Identical mussel clumps were introduced into locations differing in elevation and distance from open water in salt marshes at two geographically separate areas. Mussel mortality was greater at lower tidal elevations. At similar tidal elevations, mussels on the salt marsh interior showed less mortality than those on the marsh edge. Mortality was most likely due to predation by blue crabs Callinectes sapidus. Blue crabs and other aquatic predators forage in the salt marsh only during periods of tidal inundation and thus their feeding time decreases from low to high levels. At similar tidal elevations, their access to the marsh interior may be impeded by dense marsh grasses. (Author's abstract)
W90-02680

NEKTON USE OF REGULARLY-FLOODED SALTMARSH CORDGRASS HABITAT IN NORTH CAROLINA, USA.
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
For primary bibliographic entry see Field 2H.
W90-02681

EFFECT OF EXPORTED MANGROVE LITTER ON BACTERIAL PRODUCTIVITY AND DIS-

SOLVED ORGANIC CARBON FLUXES IN ADJACENT TROPICAL NEARSHORE SEDIMENTS.
Australian Inst. of Marine Sciences, Townsville.
D. M. Alongi, K. G. Boto, and F. Tirendi.
Marine Ecology Progress Series MESEDT, Vol. 56, No. 1-2, p 133-144, August 10, 1989. 2 fig, 7 tab, 48 ref.

Descriptors: *Mangrove swamps, *Tidal flats, *Dissolved organic carbon, *Wetlands, *Sediments, *Litter, Australia, Mercury, Interstitial water, Sediment-water interfaces, Swamps, Bacteria, Benthic fauna.

Mangrove litter is exported from tidal forests to the adjacent subtidal seabed in tropical North Queensland, Australia. Its effect on sediment characteristics and on the dynamics of benthic bacterial communities and dissolved organic carbon (DOC) fluxes was examined. Averaged over stations and seasons, mean bacterial densities in surface (0 to 1 cm) sediments ranged from 0.5 to 20.8 times 10 to the 10th power cells/gm dry weight; bacterial productivity and daily specific growth rates ranged form 0.02 to 1.86 gm C/sq m/d and from 0.004 to 0.79/d, respectively. Interstitial DOC concentrations ranged from 2.4 to 6.5 mg C/L and varied with season but not among stations. Unless sediments were poisoned with mercury, significant net efflux of DOC across the sediment-water interface was not detected despite high concentration gradients of DOC between overlying water and porewaters. Poisoning of the benthic fauna with mercury resulted in generally high rates of DOC release (range: 0 to 2.4 gm C/sq m/d). On average, DOC fluxes across the sediment-water interface provided 51% (range: 11 to 83%) of bacterial productivity requirements in surface sediments. In laboratory experiments, addition of outwelled mangrove litter (C:N = 52:1) to incubated boxcore samples did not significantly affect bacterial densities, production or growth, and DOC fluxes. The results indicate that mangrove litter exported to the adjacent nearshore of this region is highly refractory and of poor nutritional quality, with enhancement of bacterial activity and DOC fluxes apparent only in a semi-enclosed area of highest litter deposition. Rates of litter deposition appear to be low, but sufficient to influence sediment characteristics, significantly, e.g. C:N ratios and particulate organic carbon-tannin concentrations. However, subsurface burial and accumulation of litter may, via long-term degradation, support the highly abundant and productive bacterial communities and efficient bacteria-DOC recycling observed in this region. (Author's abstract)
W90-02682

NON-OCCURRENCE OF FREE-LIVING PARAMOEBA INVADENS IN WATER AND SEDIMENTS OF HALIFAX HARBOUR, NOVA SCOTIA, CANADA.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
J. F. Jellett, J. A. Novitsky, J. A. Cantley, and R. E. Scheibling.
Marine Ecology Progress Series MESEDT, Vol. 56, No. 1-2, p 205-209, August 10, 1989. 2 fig, 1 tab, 19 ref.

Descriptors: *Diseases, *Parasites, *Sediment sampler, *Echinoderms, Temperature effects, Outfall, Halifax Harbor, Injection.

Seawater and sediment samples from various sites in or near Halifax Harbor were cultured for Parameba, as were tissues of the natural sea urchin host Strongylocentrotus droebachiensis sampled from Halifax Harbor. An isolate of Parameba from a Halifax Harbor water sample was not virulent on injection into healthy sea urchins. However, some sea urchins in cages near the outfall pipe of Dalhousie University's seawater system, which contains effluent from aquaria containing disease sea urchins, were infected during the annual peak of the seawater temperature cycle. Results indicate that (1) there is no evidence of a free-living endemic population of Parameba invadens in or near Halifax Harbor; (2) S. droebachiensis, the natural host for P. invadens, do not harbour a reservoir

population of this organism at temperatures suboptimal for paramebiasis; and (3) Parameba which are morphologically indistinct from laboratory stocks of P. invadens were recovered near the outfall pipe. These organisms may have been released via the outfall pipe into Halifax Harbor and subsequently lost virulence. (Author's abstract)
W90-02683

SEASONAL VARIATIONS OF PROTEINS AND AMINO ACIDS IN THREE SALT MARSH SPECIES.
Bhavnagar Univ. (India). Dept. of Life Sciences.
A. J. Joshi, and A. S. Kumar.
Proceedings of the Indian Academy of Sciences (Plant Sciences) PIPLDS, Vol. 99, No. 3, p 287-292, June 1989. 1 fig, 2 tab, 19 ref.

Descriptors: *Marshes, *Forages, *Salt marshes, *Seasonal variation, Proteins, Amino acids, Foods, Salt tolerance, India.

Studies were conducted on the nutritive value of several salt marsh plants that grow along the coast of India. Observations on the protein content in three tropical salt marsh species, Avicennia marina, Arthrocnemum indicum and Heleochloa setulosa showed 7.3-22.8% of alkali soluble proteins in vegetative parts. Maximum concentrations were during summer. The ethanol and water soluble proteins occurred in lower concentrations than alkali soluble proteins and their content did not vary during monsoon, winter and summer. Alanine, aspartic acid, glutamic acid, glycine, methionine, phenylalanine, serine and valine occurred in greater quantity than cystine, glutamine, isoleucine, leucine and threonine. Accumulation of proline was quite high in Heleochloa, but it was not detected in Arthrocnemum and Avicennia. Similarly, arginine was absent in Avicennia and its conentration in two other species was low. Seasonal changes indicated maximum accumulation of most of the amino acids in Avicennia in summer and in Arthrocnemum and Heleochloa in monsoon. (Author's abstract)
W90-02685

EJECTION OF DROPS FROM THE SEA AND THEIR ENRICHMENT WITH BACTERIA AND OTHER MATERIALS: A REVIEW.
State Univ. of New York at Albany. Atmospheric Sciences Research Center.
For primary bibliographic entry see Field 5B.
W90-02707

EVALUATION OF MICROBIOLOGICALLY INDUCED CORROSION IN AN ESTUARY.
Naval Ocean Research and Development Activity, NSTL Station, MS.
For primary bibliographic entry see Field 8G.
W90-02708

GROWTH OF FILAMENTOUS FUNGI IN A SURFACE-SEALED WOODY SUBSTRATUM BURIED IN SALT-MARSH SEDIMENTS.
North Carolina Univ. at Wilmington. Dept. of Biological Sciences.
D. E. Padgett, D. A. Celio, J. H. Hearth, and C. T. Hackney.
Estuaries ESTUDO, Vol. 12, No. 3, p 142-144, September 1989. 1 fig, 10 ref.

Descriptors: *Fungi, *Salt marshes, *North Carolina, *Aquatic soils, Aerobic conditions, Anaerobic conditions, Oxygen diffusion, Facultative microaerophiles.

Balsa wood panels were sealed to prevent oxygen diffusion from aerobic zones and buried in a North Carolina salt marsh to determine whether filamentous fungi could invade them despite the resulting anoxia. Clavatospora bulbosa or Trichocladium achrasporum were recovered from most replicate chips taken from sealed as well as unsealed panels down to depths ranging from 5 to 11 cm. With minor exceptions the presence of one or both of theses fungi from each sampling depth down to those noted suggested the presence of uninterrupted mycelia in the upper portion of each panel.

Since the silicon seals were intact at harvest, it is apparent that fungi must have invaded sealed panels at or below the 2-or 4-inch depth and grown upward beneath the silicon 'cap' as well as downward to the levels noted. Results were similar to those of a previous study which had employed unsealed panels and suggest that fungi involved either are facultative microaerophiles or capable of translocating sufficient oxygen through their hyphae to permit growth into oxygen-deficient soil strata. (White-Reimer-PTT)
W90-02709

REASSESSMENT OF THE STATUS OF THE BENTHIC MACROFAUNA OF THE RARITAN ESTUARY.
National Marine Fisheries Service, Highlands, NJ. Sandy Hook Lab.
For primary bibliographic entry see Field 5C.
W90-02710

DISTRIBUTION AND ABUNDANCE OF EARLY LIFE HISTORY STAGES OF THE BLUE CRAB, CALLINECTES SAPIDUS, IN TIDAL MARSH CREEKS NEAR CHARLESTON, SOUTH CAROLINA.
Charleston Coll., SC. Grice Marine Biological Lab.
D. J. Mense, and E. L. Wenner.
Estuaries ESTUDO, Vol. 12, No. 3, p 157-168, September 1989. 7 fig, 6 tab, 45 ref. NOAA, Nat. Sea Grant College Dept. of Commerce Grant NA85AA-D-SG121, AM.3, AM.5.

Descriptors: *South Carolina, *Crustaceans, *Crabs, *Estuaries, Blue crab, Life cycles, Crabs, Sampling, Salinity, Distribution.

A 16-month study of estuarine habitats in poly-, meso-, and oligohaline salinity regimes near Charleston Harbor assessed the distribution and abundance of megalopae and early crab stages of the blue crab, Callinectes sapidus. Blue crab were sampled with a plankton net and a cylindrical drop sampler. Blue crab were most abundant in plankton collections at night, accounting for 68% of the megalopae and over 88% of the juveniles collected in day and night tows combined. At night, densities of megalopae were greatest in surface samples, whereas densities in daylight collections were greater on the bottom. Juvenile densities were greatest on the bottom in both day and night collections, although catch rates at night were more variable than those of the megalopae. This suggests that megalopae, and possibly juvenile stages, experience a diel vertical migration. Results indicate that ingress to estuarine nursery areas occurs at the megalopal stage. Megalopal densities were highest at the polyhaline site, while juvenile blue crab were most abundant in the oligohaline area. Habitat utilization by juvenile blue crab was estimated using a cylindrical drop sampler and Venture suction pump on three bottom types in the intertidal zone. Densities were greatest over the sandy-mud substrate, although catch rates were much lower than those reported for other geographical areas. These results suggest that juvenile blue crab do not occur in abundance on the marsh surface but remain on the creek bottom, possibly because marsh physiography and large tidal amplitudes may restrict accessibility to the marsh surface. (Author's abstract)
W90-02711

ZOOPLANKTON DISTRIBUTION IN THREE ESTUARINE BAYOUS WITH DIFFERENT TYPES OF ANTHROPOGENIC INFLUENCE.
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
For primary bibliographic entry see Field 5C.
W90-02712

HYDROGRAPHY AND CIRCULATION OF THE CHUBUT RIVER ESTUARY (ARGENTINA).
Instituto Argentino de Oceanografia, Bahia Blanca.
G. M. E. Perillo, M. C. Piccolo, M. C. Scapini, and J. Orfila.

Estuaries ESTUDO, Vol. 12, No. 3, p 186-194, September 1989. 11 fig, 1 tab, 15 ref.

Descriptors: *Argentina, *Estuaries, *Water currents, Salinity currents, Flow pattern, Hydrography, Wind-driven currents, Tidal currents, Temperature, Vertical stratification, Chubat Estuary.

The hydrography and circulation of the Chubut River were investigated under exceptionally low river discharge. During the week of December 15-18, 1986, salinity, temperature, and current velocity and direction were measured in four surveys. The frontal zone formed by the entrance of the tide in the estuary may be observed as for as 4.5 km from the mouth, showing that the salt intrusion due to tidal effects reaches further inland than during normal river discharge. Based on the classification of Hansen and Rattray, the estuary corresponds to Type I with some vertical stratification observed on the seaward side of the frontal zone. A lateral salinity gradient was found, which was not the result of the Coriolis force. The lateral salinity gradient is the result of the general morphology of the estuary. The presence of meanders and interchannel bars causes a secondary circulation driving fresh water near the surface toward the right margin and concentrating the saltier water on the left bank. Wind effect is a major component of the circulation and mixing of this shallow estuary. (Author's abstract)
W90-02713

LIVE STANDING CROP AND METABOLISM OF THE MARSH GRASS SPARTINA PATENS AS RELATED TO EDAPHIC FACTORS IN A BRACKISH, MIXED MARSH COMMUNITY IN LOUISIANA.
Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.
D. M. Burdick, I. A. Mendelssohn, and K. L. McKee.
Estuaries ESTUDO, Vol. 12, No. 3, p 195-204, September 1989. 5 fig, 2 tab, 43 ref.

Descriptors: *Wetlands, *Marsh plants, *Macrophytes, *Spartina, *Tidal marshes, Physiology, Soil chemistry, Alcohol dehydrogenase, Oxidation-reduction potential, Roots, Soil water, Biomass, Salinity, Ammonium, Sulfides, Enzymes.

Effects of soil factors on physiological indicators of Spartina patens and live standing crop of the macrophyte community were investigated in a brackish marsh. Three distinct physiognomic zones were studied along a transect perpendicular to a tidal creek: the marsh edge, which was directly adjacent to the creek; the levee berm, 6 to 8 m from the creek; and the inland zone, which extended through the marsh interior. Soil physicochemical factors (soil moisture, redox potential, interstitial pH, salinity, and ammonium and sulfide concentrations) were compared to physiological indicators of Spartina patens (leaf adenine nucleotides, root alcohol dehydrogenase (ADH) activity, and level of ethanol, lactate, alanine and malate in the roots). In correlation matrices of soil and plant factors, increases in soil moisture and decreases in redox potential were associated with depressed leaf adenylate energy charge ratios (AEC, an integrative measure of plant stress) and elevated ADH activities and metabolite levels in the roots. ADH activity was greatest in roots from the inland zone where soil waterlogging was greatest and exhibited seasonal increases that followed seasonal declines in soil redox potential. Leaf AEC was greatest in the berm and generally lowest in the inland plants. End of season live standing crop was also greatest on the berm, but did not closely follow any edaphic trends across the three zones. This suggests that several factors, (i.e., soil aeration, and sulfide and nitrogen levels) may be of greater importance to standing crop than any single factor, as is thought for salt marshes dominated by S. alterniflora. (Author's abstract)
W90-02714

AMPHIPOD PREDATION BY THE INFAUNAL POLYCHAETE, NEPHTYS INCISA.
Science Applications International Corp., Narra-

gansett, RI.
For primary bibliographic entry see Field 5C.
W90-02715

MODELING FATE AND TRANSPORT OF NUTRIENTS IN THE JAMES ESTUARY.
Virginia Univ., Charlottesville. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-02721

ESTIMATING ESTUARINE REAERATION RATES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydrology Lab.
C. F. Cerco.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 115, No. 5, p 1066-1070, October 1989. 2 fig, 1 tab, 6 ref.

Descriptors: *Oxygenation, *Oxygen transfer, *Estuaries, *Reaeration, Tidal velocity, Water depth, Wind, Mass transfer, Mathematical models, Flow, Bottom stress.

Predicted reaeration rates generated by wind and bottom stress were compared for typical combinations of tidal velocity, depth, and wind speed. Reaeration is computed as the product of a mass-transfer coefficient and the oxygen deficit of the water body. Selection of an appropriate formula partly depends on the physical characteristics of the water body, and the formula of O'Connor and Dobbins is appropriate for estuaries. Predicted mass-transfer coefficients induced by bottom and wind stress were then compared for combinations of mean tidal velocity, depth, and wind speed likely to be encountered in estuaries. Results indicate all reaeration formulas are, at best, approximate relationships from which observed rates may substantially differ. Observed reaeration rates in rivers may deviate by half an order of magnitude from equation predictions. A fraction of the deviations can be attributed to methodological problems inherent in reaeration measurements. The discrepancies also indicate, however, that existing formulas do not account for all processes that influence reaeration. In estuaries, potential influences that are neglected include effects of unsteady flow, vertical density gradient, variable winds, and interactions of wind and bottom stress. (White-Reimer-PTT)
W90-02726

HYDRAULIC MODELLING OF TIDAL CIRCULATION AND FLUSHING IN COASTAL BASINS.
Washington Univ., Seattle.
For primary bibliographic entry see Field 6G.
W90-02807

COASTAL LAGOONS OF BRITAIN: AN OVERVIEW AND CONSERVATION APPRAISAL.
Cambridge Univ. (England). Dept. of Zoology.
R. S. K. Barnes.
Biological Conservation BICOBK, Vol 49, No. 4, p 295-313, 1989. 4 fig, 3 tab, 31 ref, append.

Descriptors: *England, *Coastal lagoons, *Coastal waters, *Coastal zone management, *Environmental protection, Species diversity, Conservation.

Britain possesses a total of 41 remaining coastal lagoon sites, many former lagoons having disappeared as a result of natural causes (including evolution into freshwater lakes) and human interference. All British lagoons are isolated behind barriers of shingle (with or without admixture of sand) and most receive sea-water influx only by percolation through, or occasional overtopping of, this shingle. As such, they are of unusual 'North Atlantic' physiographic types from a global viewpoint. Their macrofaunal species richness varies with lagoonal salinity and area (although these account for only 21% of the variation), the number of specialist lagoonal species within any given system is directly related to total species richness. A comparative site assessment, leading to identification of the nationally most important la-

goonal systems was conducted based on a ten point scale, and ten lagoons were selected as being nationally noteworthy. (Author's abstract)
W90-02810

SUCCESSION PATTERNS OF PHYTOPLANKTON BLOOMS: DIRECTIONALITY AND INFLUENCE OF ALGAL CELL SIZE.
Instituto de Ciencias del Mar, Barcelona (Spain).
C. Marrase, C. M. Duarte, and D. Vaque.
Marine Biology MBIOAJ, Vol. 102, No. 1, p 43-48, Jul 1989. 4 fig, 1 tab, 26 ref. CAICYT and the Instituto de Ciencias del Mar, C.S.I.C. Grant PR84-0061.

Descriptors: *Estuaries, *Harbors, *Phytoplankton, *Eutrophication, *Succession, Seasonal variability, Biomass, Size, Species diversity, Density.

A phytoplankton bloom was induced by enclosing a natural community sampled from Masnou Harbor (N.E. Spain) in November 1987, and the pattern of algal succession during the bloom was examined. Good replicability of the temporal patterns of the community biomass and the abundance of most species demonstrated that succession was a directional, non-random process. The successional pathway observed (small flagellates to small centric diatoms to small flagellates) resembled that observed by other authors studying phytoplankton blooms. This pattern differed from previous models of algal succession in that dinoflagellates never comprised a substantial fraction of the community biomass, and algal cell size did not tend to increase along the successional sequence. However, algal cell size was an important determinant of phytoplankton community structure since it constrained the density, but not the biomass, achievable by the different species. It is suggested that there is not a single pattern of phytoplankton succession, and that a distinction should be made, at least between seasonal and bloom patterns of phytoplankton succession. (Author's abstract)
W90-02821

EFFECT OF TIDAL CURRENTS, SESTON, AND BOTTOM SEDIMENTS ON GROWTH OF MERCENARIA MERCENARIA: RESULTS OF A FIELD EXPERIMENT.
Rutgers - The State Univ., New Brunswick, NJ. Center for Coastal and Environmental Studies.
R. E. Grizzle, and P. J. Morin.
Marine Biology MBIOAJ, Vol. 102, No. 1, p 85-93, Jul 1989. 3 fig, 5 tab, 57 ref. NOAA Sea Grant No. NA85AA-D-SG084.

Descriptors: *Mollusks, *Clams, *Tidal effects, *Seston, New Jersey, Growth, Bottom sediments, Sand, Mud, Organic matter, Particulate matter, Clams.

Tidal currents, seston, and sediments separately influence growth of the hard clam, Mercenaria mercenaria, but it is uncertain how these factors may interact. A 3 x 3 factorial field experiment, carried out in Great Sound, a coastal lagoon in Southern New Jersey, USA, between May and September 1986, determined the relative effects of three sediment types and three site-specific seston tidal current regimes on the individual growth of M. mercenaria. Analysis of variance of the change in shell length after 15 wk (differences in initial and final lengths) demonstrated a significant difference (P=0.0064) in growth among sites, but no significant differences (P=0.1331) for growth in different sediments, although trends were evident. Effects of sites were independent of sediment type (P=0.2621). Shell growth rates differed by 10.7% between the slowest and fastest sites, but only differed by 5.7% between sediment types, with fastest growth in sand and slowest in mud. Tidal current speeds and four measures of seston (chlorophyll a, particulate inorganic and organic matter, and energy content) were measured >20 times in near-bottom waters at each site. Horizontal fluxes of particulate organic matter exhibited higher correlation coefficients with growth rates, than did seston concentrations or current speeds alone. Significant 'site' differences were attributed to differences in horizontal seston fluxes among sites. It is suggested that horizontal seston fluxes may be a

major factor affecting individual growth of suspension-feeding bivalves. (Author's abstract)
W90-02822

COMPARISON OF THREE TECHNIQUES FOR ADMINISTERING RADIOLABELED SUBSTRATES TO SEDIMENTS FOR TROPHIC STUDIES: UPTAKE OF LABEL BY HARPACTICOID COPEPODS.
Florida State Univ., Tallahassee. Dept. of Oceanography.
For primary bibliographic entry see Field 7B.
W90-02823

FATE OF FENTHION IN SALT-MARSH ENVIRONMENTS: I. FACTORS AFFECTING BIOTIC AND ABIOTIC DEGRADATION RATES IN WATER AND SEDIMENT.
Environmental Protection Agency, Gulf Breeze, FL. Gulf Breeze Environmental Research Lab.
For primary bibliographic entry see Field 5B.
W90-02837

FATE OF FENTHION IN SALT-MARSH ENVIRONMENTS: II. TRANSPORT AND BIODEGRADATION IN MICROCOSMS.
Technical Resources, Inc., Gulf Breeze, FL.
For primary bibliographic entry see Field 5B.
W90-02838

BIOASSAY OF ACUTE TOXICITY OF HERBICIDE MIXTURE DALAPON/WEEDAZOL 4L ON ESTUARINE FAUNA.
Cawthron Inst., Nelson (New Zealand). Aquatic Resources Group.
For primary bibliographic entry see Field 5C.
W90-02843

COMPARISON OF TIDAL MODELS FOR THE SOUTHWEST COAST OF VANCOUVER ISLAND.
Institute of Ocean Sciences, Sidney (British Columbia).
M. G. G. Foreman.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 231-236, 2 fig, 2 tab, 9 ref.

Descriptors: *British Columbia, *Vancouver Island, *Tidal currents, *Coastal waters, *Model studies, *Tides, *Mathematical models, Finite difference methods, Finite element method, Comparison studies, Performance evaluation, Advection, Friction, Error analysis, Model testing.

Preliminary results are presented of a comparison between one finite-difference and two finite-element models, which were applied to the southwest coast of Vancouver Island, with the eventual aim of predicting barotropic tidal currents to support an upcoming field program. The finite-difference model was developed by Flather, whereas the finite-element models were based on early work by Lynch and Gray and developed further by Werner and Lynch and Walters. Accuracy was evaluated by comparing model results with observations from 12 tide gauges and 12 tide current meters. The roles of advection and bottom friction in the correct representation of the M2 and K1 tidal constituents are studied. The K1 amplitude constituent is particularly interesting because it contains a substantial contribution in the form of a continental shelf wave. The triangular grid for the finite-models contained 1548 nodes, 2723 elements, and triangle sides varying from 2.2 to 42 km. Errors at each of the 24 observation sites reveal regions where the model performance might be improved. In addition to these site-specific errors, there were three obvious general sources of errors in all three models: (1) tides in the region are baroclinic and barotropic, but the models are barotropic only, so

that exact reproduction of observations cannot be expected; (2) model resolution was insufficiently fine; model resolution should be made finer to reduce both error measures; and (3) M2 and K1 account for only about half the total diurnal and semi-diurnal tide range along the Vancouver island coast; inclusion of additional, presently neglected, constituents can be expected to modify the M2 and K1 results. Future work will include more rigorous comparisons of model results with observations, attempts to improve model accuracy in problem regions, the implementation of the three-dimensional Lynch and Werner model, and the inclusion of six additional tidal constituents with aim of accounting for about 90% of the tidal range along the coast. (See also W90-02980) (Rochester-PTT)
W90-03013

COMPUTATION OF CURRENTS DUE TO WIND AND TIDE IN A LAGOON WITH DEPTH-AVERAGED NAVIER-STOKES EQUATIONS (ULYSSE CODE).
Electricite de France, Chatou. Direction des Etudes et Recherches.
J. M. Hervouet.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 237-242, 3 fig.

Descriptors: *Water currents, *Tidal currents, *Model studies, *Tunisia, *Tidal hydraulics, *Wind effects, Tides, Lagoons, Turbulent flow, Supercomputers, Computer models, ULYSSE computer program, Retention time, Finite difference methods, Economic development, Tracers, Advection, Diffusion.

Mixing was examined mathematically in Ghar-El-Mehl Lagoon, Tunisia, which is located near the Farina Cape and is scheduled for development of tourism facilities (marina, wharfs, and hotels). Tide, wind, turbulence, and bottom friction were considered in computation of currents using the Cray XMP running the curvilinear finite difference code ULYSSE. A non-orthogonal mesh, with approximately 6000 nodes, was designed using elliptic equations using the 'PENELOPE' code. To follow the sea water in the lagoon, a tracer with an initial value of 100 in the sea and 0 in the lagoon was used; the tracer was the solution of an advection-diffusion equation. Two types of computation were done: (1) with tide only and (2) with tide and a 5 m/sec west wind. It was found that nearly 5% of the water in the lagoon was renewed during a single tide with wind, so that the retention time of water was 10 days. It would have been 13 days without wind. (See also W90-02980) (Rochester-PTT)
W90-03014

SHALLOW WATER WAVE EQUATIONS ON A VECTOR PROCESSOR.
Notre Dame Univ., IN. Dept. of Civil Engineering.
I. P. E. Kinmark, and W. G. Gray.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 243-248, 1 fig, 8 ref.

Descriptors: *Shallow water, *Computers, *Model studies, *Vector processors, *Waves, *Open-channel flow, *Supercomputers, Computer models, Performance evaluation, Mathematical equations, Comparison studies, Computer programs.

The current study examined the overall execution time, scalar versus vector performance, and effect of reprogramming when a computationally intensive finite-element wave equation model was used on a Cray X-MP/48, a computer with vector processing capability. The application is a one-dimensional open-channel flow problem. The horizontal channel is closed at one end and subject to a sinusoidal forcing of the elevation at the opposite end. Reprogramming was mainly directed toward the matrix set-up routine in this problem. Overall, the total original flow code experienced a speedup of approximately a factor of 2 using the vector processor capability of the Cray X-MP/48. Another factor of 6 speedup was obtained in the scalar mode on the Cray X-MP/48 compared to the IBM 3033 for which the code was originally designed. Thus, a total speedup of a factor of 12 was obtained, thus allowing the code to be run on much larger field data sets and even multiple runs for parameter identification. To achieve significantly higher speedups, the basic numerical algorithms must be designed specifically with the vector processor in mind, thus necessitating the need to create a new code largely from scratch. (See also W90-02980) (Rochester-PTT)
W90-03015

TESTING OF FINITE ELEMENT SCHEMES FOR LINEAR SHALLOW WATER EQUATIONS.
Vatnaskil, Reykjavik (Iceland).
For primary bibliographic entry see Field 2H.
W90-03016

LONG TERM SIMULATION AND HARMONIC ANALYSIS OF NORTH SEA/ENGLISH CHANNEL TIDES.
Thayer School of Engineering, Hanover, NH.
D. R. Lynch, and F. E. Werner.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 257-266, 13 fig, 1 tab, 13 ref. NSF Grant CEE

Descriptors: *North Sea, *English Channel, *Tides, *Tidal hydraulics, *Model studies, *Simulation, *Harmonic analysis, Long-term studies, Comparison studies, Mathematical models, Time series analysis, Data filtering.

A long-term simulation and harmonic analysis of North Sea/English Channel tides that was presented in 1987 is extended. A longer-term simulation is used here to distinguish among various harmonic constituents that were lumped together in the previous report. Using a 184-day record, it was possible to fit with confidence to 51 tidal constituents. Of these 51 constituents, most of the energy was indeed recovered in the 11 constituents used in the forcing, although the non-linear interactions in the model have put some energy into other harmonics. For the tidal-elevation time-series at the 11 coastal stations, the 1987 comparisons were not as satisfying as the harmonic comparisons obtained here. It was concluded that the data should be considered as filtered, and that the most appropriate comparison would be with simulation results passed through an identical filter. Indeed, visual comparison of the field data for the 11 constituents with filtered and unfiltered simulation results shows that the filtered simulation results generally agree better with the data than do the unfiltered results. (See also W90-02980) (Rochester-PTT)
W90-03017

TIDAL MOTION IN THE ENGLISH CHANNEL AND SOUTHERN NORTH SEA: COMPARISON OF VARIOUS OBSERVATIONAL AND MODEL RESULTS.
Liege Univ. (Belgium). Inst. de Mathematique.
J. Ozer, and B. M. Jamart.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 267-273, 1 tab, 8 ref.

Descriptors: *Mathematical models, *Model studies, *North Sea, *English Channel, *Tides, *Tidal hydraulics, *Comparison studies, Hydraulic models, Field tests, Sea truth, Tidal Forum, Simulation.

A conventional finite-difference, time-stepping (semi-implicit) model is entered in the model intercomparison exercise know as the 'Tidal Forum.' The results of that model are compared to those obtained 1987 for the English Channel and southern North Sea. A distinction is proposed between two kinds of simulation: (1) 'time domain simulation,' i.e., a time-stepping computation starting with the water at rest and covering a period of only a few days; (2) 'spectral approach,' in which the harmonic constituents are calculated, either directly or indirectly. The reference to 'sea truth' data proposed in the Tidal Forum exercise consists of a harmonic reconstitution of 'observed' tidal heights and time series of currents at several locations. When evaluated against that benchmark, the results of the spectral approach are more satisfactory than those of time domain simulations. The comparison of the Tidal Forum reference data set with observations available from other sources suggests that some effort to tighten the definition of the sea truth would be worthwhile. (See also W90-02980) (Author's abstract)
W90-03018

EXPERIMENTS ON THE GENERATION OF TIDAL HARMONICS.
Geological Survey, Tacoma, WA.
R. A. Walters, and F. E. Werner.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 275-280, 6 ref.

Descriptors: *Tidal waves, *Mathematical analysis, *Tidal hydraulics, *Model studies, Harmonic analysis, Numerical analysis, Mathematical models, Mathematical equations, Waves, Tidal energy, Advection, Friction, Shallow water.

The dependent variables in the shallow-water equations, sea level and velocity, are expanded in a time-average plus the sum of periodic components whose frequencies are known. Following harmonic decomposition, the equations are solved for sea level, resulting in an elliptic equation for sea level and two components of the momentum equation. Time-stepping methods are not used. Rather, the dependent variables are the complex amplitudes. In the present work, the effects of various approximations to the non-linear terms are examined, namely, wave transport, advection, and bottom friction. The present numerical experiments aimed to assess the ability of the frequency-domain model to reproduce the nonlinear source generation terms. The method used here entails making calculations for a simplified set of constituents in an irregular network, and examining the effects of the various source terms. The results are compared to those from a time-domain model (the explicit wave equation model of Werner and Lynch). The network used in the study encompassed the English Channel and southern North Sea and includes 990 nodes and 1762 elements. The network and an observational data set were obtained through the Tidal Flow Forum. Based on the observations and results from another model, the frequency-domain model is capable of reproducing the correct source terms for the overtides. However, a practical limit in frequency when using this approach seems to be the sexto-diurnal constituents, because of the increasing complexity of the source terms as frequency increases. This limit is tempered by the fact that there is little energy in the higher frequency constituents. (See also W90-02980) (Rochester-PTT)
W90-03019

2D MODEL FOR TIDAL FLOW COMPUTATIONS.
Katholieke Univ. Leuven (Belgium). Dept. of Civil

Engineering.
C. S. Yu, M. Fettweis, and J. Berlamont.
IN: Computational Methods in Water Resources:
Vol. 1. Modeling Surface and Sub-Surface Flows:
Proceedings of the VII International Conference
on Computational Methods in Water Resources,
Massachusetts Institute of Technology, Cam-
bridge, MA, June 1988. Elsevier, Amsterdam, and
Computational Mechanics Publications, Southamp-
ton (co-publishers). 1988. p 281-286, 3 fig, 7 ref.

Descriptors: *Mathematical models, *Atlantic
Ocean, *Europe, *Continental shelf, *Tidal hy-
draulics, *Model studies, Tidal amplitude, Sea
level, Finite difference methods, Tidal currents,
Differential equations, Falsification, Shallow
water.

A two-dimensional, depth-averaged numerical
model for tidal flow computation applies the finite-
difference method together with a falsified alter-
nating-direction implicit (FADI) scheme to solve
the shallow water equations. The possibility of
using grid refinement is included in the model. The
computational order of the equations at both odd
and even time-steps was pre-managed into a coeffi-
cient matrix. To make a continuous implicit com-
putation of each line, both grid systems were
linked together. By this means, both the coarse and
fine grid are solved simultaneously. This model
was applied to calculate the tidal flows of the
Northwest European Continental Shelf. The shelf
model represents an area from 12 deg W longitude
to the Baltic Sea and from 48 deg N to 61 deg N
latitude. The fine grid includes the southern North
Sea and the English Channel. The coarse grid size
is 24 x 24 sq km and the fine grid size is 8 x 8 km.
The time step chosen was 447 seconds and the
water elevations and momentum of the model
were started from rest. After a few tidal cycles the
sea surface reaches a stable condition and the re-
sults are stored in a file that is used as the initial
condition for later runs. Tidal currents were com-
puted for six tidal components. The computational
results generally agreed with those obtained with
other models, such as the three-dimensional spec-
tral model of Davies. The grid size was too large
to reproduce the amphidromic point in the North
Channel of the Irish Sea because this region is not
included in the fine grid computations. The present
FADI scheme is more efficient than conventional
implicit schemes because of the falsification of the
differential equations. (See also W90-02980) (Roch-
ester-PTT)
W90-03020

SYSTEM IDENTIFICATION AND SIMULA-
TION OF CHESAPEAKE BAY AND DELA-
WARE BAY CANAL HYDRAULIC BEHAVIOR.
Maryland Dept. of Natural Resources, Annapolis.
B. B. Hsieh.
IN: Computational Methods in Water Resources:
Vol. 1. Modeling Surface and Sub-Surface Flows:
Proceedings of the VII International Conference
on Computational Methods in Water Resources,
Massachusetts Institute of Technology, Cam-
bridge, MA, June 1988. Elsevier, Amsterdam, and
Computational Mechanics Publications, Southamp-
ton (co-publishers). 1988. p 313-318, 3 fig, 1 tab, 6
ref.

Descriptors: *Chesapeake Bay, *Delaware Bay,
*Canals, *Shallow water equations, *Simulation
analysis, *Tidal hydraulics, *Waves, *Model stud-
ies, Mathematical models, Hydraulic models, Sto-
chastic models, Tidal currents, Statistics, Kalman
filtering, Estuaries, Elk River, Numerical analysis,
Comparison studies, Prediction.

The Kalman filter combined with a one-dimension-
al shallow-water wave equation was applied to
describe the tidal hydraulic behavior of the Chesa-
peake Bay and Delaware Bay canal (C and D
canal). This model joins two separate estuarine
systems and one branched estuarine waterway in
the Elk River area. The field measurements from
surface water elevations and tidal currents are used
to calibrate this stochastic-deterministic model.
The agreement between field observations and the
filtered estimate is better than between field results
and the purely numerical solution. The model per-
formance was evaluated by statistical methods.

Harmonic analysis was employed to examine the
consistency of tidal constituents between field
measurements and the numerical solution. The am-
plitude and phase angle for major components of
diurnal and semi-diurnal frequency bands were cal-
culated. The dominant components, such as M2,
S2, and N2, do not vary much (5-10%). The F-test
was employed to determine how the stochastic-
deterministic approach is superior to the purely
numerical solution. Both tidal elevations and tidal
currents were significant at the 0.01 level in terms
of model prediction error covariance. Extending
the modeling process to the system noise and the
measurement noise provide much better predic-
tions and can be used to simulate the special forc-
ing events. (See also W90-02980) (Rochester-PTT)
W90-03025

SATELLITE OBSERVATIONS OF OCEANS
AND ICE.
Cold Regions Research and Engineering Lab.,
Hanover, NH.
For primary bibliographic entry see Field 7B.
W90-03034

NEW FAMILY OF SHAPE FUNCTIONS.
Mississippi Univ., University. Dept. of Mechanical
Engineering.
For primary bibliographic entry see Field 7C.
W90-03053

ASSESSMENT OF THERMAL IMPACTS OF
DISCHARGE LOCATIONS USING FINITE
ELEMENT ANALYSIS.
Stone and Webster Engineering Corp., Boston,
MA.
For primary bibliographic entry see Field 5B.
W90-03081

INTERACTIVE DESIGN OF IRREGULAR TRI-
ANGULAR GRIDS.
Institute of Ocean Sciences, Sidney (British Co-
lumbia).
R. F. Henry.
IN: Computational Methods in Water Resources,
Vol.2: Numerical Methods for Transport and Hy-
drologic Processes. Elsevier, New York. 1988. p
445-450, 3 ref.

Descriptors: *Computer programs, *Model studies,
*Shallow water, *Coastal waters, Grids, Design,
Graphics, Computers, Canada.

An integrative software package is described that
is used at the Institute of Ocean Sciences (Canada)
for construction of irregular triangular grids suita-
ble for shallow water models. The grids obtained
represent a compromise among the following
design requirements: (1) close fitting of coastlines;
(2) near-uniform element area/water depth ratio;
and (3) near-equilateral element shape. The main
innovations are an indirect method of creating
appropriately-spaced vertices for the triangles, an
interactive graphical editor that facilitates altera-
tions to a grid based on visual judgments, and the
dual use of the same software for both depth and
model grids. Extensive use is made of color graph-
ics throughout the initial grid construction phase as
well as in subsequent interactive editing. The prin-
cipal output file contains a record for each grid
vertex, specifying the location of the vertex, the
local mean water depth, a computational code
indicating whether the vertex is in the model inte-
rior or requires some specific boundary computa-
tion, and a list of neighboring vertices to which it
is connected. Subsidiary outputs, such as triangle
lists, also can be produced if required,. The soft-
ware is written in VAX FORTRAN and uses the
ISSCO DISSPLA graphics package; it is imple-
mented under the MVS operating system on the
VAX 11/785. (See also W90-03036) (Rochester-
PTT)
W90-03101

INTERNAL LEE WAVES IN TURBULENT
TWO-LAYER FLOW.
Technische Hogeschool Delft (Netherlands). Dept.
of Civil Engineering.

C. Kranenburg, and J. D. Pietrzak.
Journal of Hydraulic Engineering (ASCE)
JHEND8, Vol. 115, No. 10, p 1352-1370, Oct 1989.
7 fig, 2 tab, 25 ref.

Descriptors: *Mathematical models, *Internal
waves, *Turbulent flow, *Hydrodynamics, *Estu-
aries, *Stratified flow, *Density stratification, To-
pography, Flow friction, Saline-freshwater inter-
faces, Mixing.

Small density differences influence the hydrodyna-
mics of most estuaries because of the proximity of
the sea and the discharge of fresh river-water. The
resulting stable density stratification in stratified
and partially stratified estuaries opens the possibili-
ty of internal wave generation. The wave motion is
termed internal to indicate that the presence of a
free surface is not essential. Internal-wave fields
induced by bottom topography may have an effect
on salt intrusion and fine-sediment transport. A
mathematical model and laboratory experiments
are described that deal with two-layer flow over
small-scale bottom topography in relatively shal-
low, (partially) stratified estuaries. The mathemati-
cal model is based on Boussinesq-type equations,
which in an approximate way account for vertical
accelerations, and assumes quasi-steady flow. The
analysis included the effect of turbulent friction at
bottom and sidewalls. In the experiments the posi-
tions of the interface, horizontal velocities, and
turbulence intensities were measured. An increase
in turbulence level downstream of the obstacle was
observed, and a fair agreement with predicted lee-
wave amplitudes, wavelengths, and wave damping
was obtained. The calculated lee-wavelengths
compare favorably with the observations up to an
internal Froude number of 0.90. Above a Froude
number of about 0.90, a steady-state situation no
longer developed, the flow remaining markedly
unsteady. In near-critical conditions nonlinear ef-
fects caused the undular lee wave to transform into
an internal hydraulic jump. No significant up-
stream effects were observed in a steady-state situ-
ation, presumably because of the low obstacle
height. Almost no mixing between the layers was
observed because the velocity differences were
small. (Author's abstract)
W90-03221

ANNUAL PATTERNS OF DENITRIFICATION
AND NITRATE AMMONIFICATION IN ESTU-
ARINE SEDIMENT.
Aarhus Univ. (Denmark). Inst. of Ecology and
Genetics.
K. S. Jorgensen.
Applied and Environmental Microbiology
AEMIDF, Vol. 55, No. 7, p 1841-1847, July 1989.
4 fig, 1 tab, 39 ref.

Descriptors: *Estuaries, *Denitrification, *Ni-
trates, *Marine sediments, *Seasonal variation,
*Ammonification, Denmark, Spatial distribution,
Aquatic bacteria.

The seasonal variation and depth distribution of
the capacity for denitrification and dissimilatory
$NO_3(-)$ reduction to $NH_4(+)$ ($NO_3(-)$ ammonifica-
tion) were studied in the upper 4 cm of the sedi-
ment of Norsminde Fjord estuary, Denmark. A
combination of C2H2 inhibition and N15 isotope
techniques was used in intact sediment cores in
short-term incubations (maximum, 4 hr). The deni-
trification capacity exhibited two maxima, one in
the spring and one in the fall, whereas the capacity
for $NO_3(-)$ ammonification was maximal in the late
summer, when sediments were progressively re-
duced. The denitrification capacity was always
highest in the uppermost 1 cm of the sediment and
declined with depth. The $NO_3(-)$ ammonification
was usually higher with depth, but the maximum
activity in late summer was observed within the
upper 1 cm. The capacity for $NO_3(-)$ incorporation
into organic material was investigated on two oc-
casions in intact sediment cores and accounted for
less than 5% of the total $NO_3(-)$ reduction. Deni-
trification accounted for between 13 and 51% of
the total $NO_3(-)$ reduction, and $NH_4(+)$ produc-
tion accounted for between 4 and 21%, depending
on initial rates during the time courses. Changes of
the rates during the incubation were observed in

the late summer, which reflected synthesis of denitrifying enzymes. This time lag was eliminated in experiments with mixed sediment because of preincubation with NO3(-) and alterations of the near-environmental conditions. The initial rates obtained in intact sediment cores therefore reflect the preexisting enzyme content of the sediment. (Author's abstract)
W90-03237

EFFECTS OF SUSPENDED SEDIMENT, HYPOXIA, AND HYPEROXIA ON LARVAL MERCENARIA MERCENARIA (LINNAEUS, 1758).
Delaware Univ., Lewes. Coll. of Marine Studies.
For primary bibliographic entry see Field 5C.
W90-03261

ENVIRONMENTAL INFLUENCES ON THE OYSTER INDUSTRY ALONG THE WEST COAST OF FLORIDA.
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 6G.
W90-03263

INTERFACIAL MIXING IN STRATIFIED CHANNEL FLOWS.
Nebraska Univ.-Lincoln. Dept. of Civil Engineering.
J. P. Grubert.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 7, p 887-905, July 1989. 8 fig, 2 tab, 30 ref.

Descriptors: *Channel flow, *Thermal stratification, *Density stratification, *Stratified flow, *Saline-freshwater interfaces, Mixing, Mathematical models, Hydraulics, Estuaries, Fjords.

Mathematical models of stratified channel flows require equations which can predict the onset of interfacial mixing and compute the rate of mixing. Experiments show that although certain equations can predict entrainment rates in wind-driven lakes, no reliable experimental equations exist for estuarine flows. The problem appears to be that in laboratory channels, there is not always complete dynamic similarity between experimental and prototype flows. This is because the interfacial layer in the experiment may be in a quasi-laminar state while that in the prototype may be completely turbulent, leading to different rates of mixing. In view of this, care must be taken to ensure that any experimentally derived mixing equation is compatible with the flow conditions in the prototype. In essence this means that any estuarine mixing equation, either for entrainment mixing or turbulent diffusion mixing, must be expressed not only in terms of the bulk Richardson number but also in terms of the interfacial and boundary friction factors. Mixing experiments were performed in both Plexiglass and concrete channels of different dimensions. The experimental results yielded three different equations, the first expressed in terms of a shear velocity, a shear Richardson number, and a densimetric Reynolds number; the second, a typical entrainment type equation but expressed in terms of a total shear velocity and a boundary shear Richardson number; the third, expressed in terms of a Richardson number and the ratio of the boundary to the interfacial friction factors. When these equations are compared with data from well-known experiments, the agreement is good. The best equation to use for entrainment mixing in estuaries and fjords in the same equation which is used for lakes and seas, but with the boundary friction replaced with an average friction factor. When the interfacial layer is in a critical or supercritical state, turbulent diffusion mixing is taking place and other equations must be used. (Ence-PTT)
W90-03331

EXPERIMENTAL INVESTIGATION OF SHALLOW RECIRCULATING FLOWS.
McGill Univ., Montreal (Quebec). Dept. of Civil Engineering and Applied Mechanics.
S. Babarutsi, J. Ganoulis, and V. H. Chu.
Journal of Hydraulic Engineering (ASCE)

JHEND8, Vol. 115, No. 7, p 906-924, July 1989. 15 fig, 1 tab, 36 ref.

Descriptors: *Path of pollutants, *Flow pattern, *Water currents, *Open-channel flow, Shallow water, Hydraulics, Shear, Turbulent flow, Flow friction, Bed friction.

Shallow recirculating flows commonly occur in nature, in bays and harbors, behind islands, around coastal inlets, and as coastal effluents reattach to the shoreline. Experiments were conducted to study the bed-friction influence in the recirculating zone of a shallow open-channel flow. Velocity measurements were made using a hot-film anemometer. The recirculating flow rate and the length of the recirculating zone were determined from the measurements, and they were related to a horizontal length scale and a bed-friction length scale. For deep flows, the results were independent of the bed-friction length scale. For shallow flows, the results were independent of the horizontal length scale. Turbulence in the recirculating flows is generated by the bed friction and by the transverse shear. The bed-generated component is proportional to the bed-friction velocity. The transverse component is confined to a transverse mixing region. In the limit of shallow water depth, when the flow is under strong bed-friction influence, both the transverse mixing region and the recirculating zone have the same length of about one friction length scale. (Author's abstract)
W90-03332

DEPLETION OF HEAVY ISOTOPES OF OXYGEN AND HYDROGEN IN TISSUE WATER OF INTERTIDAL PLANTS: IMPLICATIONS FOR WATER ECONOMY.
California Univ., Los Angeles. Dept. of Earth and Space Sciences.
For primary bibliographic entry see Field 2I.
W90-03342

MERCURY DISTRIBUTION IN MARITIME SEDIMENT AND ITS CORRELATION WITH THE POSIDONIA OCEANICA PRAIRIE IN A COASTAL AREA AFFECTED BY A CHLOR-ALKALI COMPLEX.
Consiglio Nazionale delle Ricerche, Pisa (Italy). Ist. di Biofisica.
For primary bibliographic entry see Field 5B.
W90-03347

HEAVY METALS IN COASTAL SEDIMENTS IN GUIPUZCOA (SPAIN).
Universidad del Pais Vasco, San Sebastian (Spain). Lab. Contaminacion.
For primary bibliographic entry see Field 5B.
W90-03350

BENTHIC BACTERIAL BIOMASS AND PRODUCTION IN THE HUDSON RIVER ESTUARY.
Georgia Univ., Athens. Inst. of Ecology.
For primary bibliographic entry see Field 2H.
W90-03370

PHENANTHRENE MINERALIZATION ALONG A NATURAL SALINITY GRADIENT IN AN URBAN ESTUARY, BOSTON HARBOR, MASSACHUSETTS.
Massachusetts Univ. at Boston. Dept. of Biology.
For primary bibliographic entry see Field 5B.
W90-03372

SEASONAL CHANGES OF CADMIUM AND COPPER LEVELS IN STEM-BORING LARVAE OF AGAPANTHIA VILLOSOVIRIDESCENS (COLEOPTERA) ON SALT MARSHES OF THE WESTERSCHELDE ESTUARY.
Delta Inst. for Hydrobiological Research, Yerseke (Netherlands).
For primary bibliographic entry see Field 5B.
W90-03426

CADMIUM INDUCED MALFORMATION IN EYES OF AMBASSIS COMMERSONI CUVIER.

Central Electrochemical Research Inst., Karaikudi (India).
For primary bibliographic entry see Field 5C.
W90-03427

CHANGES INDUCED BY CADMIUM IN THE KIDNEY OF BLACK SEA BREAM, MYLIO MACROCEPHALUS (TELEOSTEI).
Chinese Univ. of Hong Kong, Shatin. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W90-03429

TOXICITY OF THE ORGANOPHOSPHATE INSECTICIDE FENTHION, ALONE AND WITH THERMAL FOG CARRIERS, TO AN ESTUARINE COPEPOD AND YOUNG FISH.
New England Univ., Biddeford, ME. Div. of Life Sciences.
For primary bibliographic entry see Field 5C.
W90-03432

ZINC ACCUMULATION IN FIDDLER CRABS UCA ANNULIPES LATREILLE AND UCA TRIANGULARIS (MILNE EDWARDS).
Mississippi Univ. Medical Center, Jackson. Dept. of Neurology.
For primary bibliographic entry see Field 5B.
W90-03436

EFFECTS OF CADMIUM AND PCBS ON REPRODUCTION OF THE SEA STAR ASTERIAS RUBENS: ABERRATIONS IN THE EARLY DEVELOPMENT.
Utrecht Rijksuniversiteit (Netherlands). Research Group for Aquatic Toxicology.
For primary bibliographic entry see Field 5C.
W90-03438

RENAL LESIONS IN ESTUARINE FISHES COLLECTED FROM THE ELIZABETH RIVER, VIRGINIA.
William and Mary Coll., Gloucester Point, VA. Inst. of Marine Science.
For primary bibliographic entry see Field 5C.
W90-03445

INFLUENCE OF DIETARY AND WATER-BORNE ZINC ON HEAT-STABLE METAL LIGANDS IN RAINBOW TROUT, SALMO GAIRDNERI RICHARDSON: QUANTIFICATION BY (109)CD RADIOASSAY AND EVALUATION OF THE ASSAY.
McMaster Univ., Hamilton (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5C.
W90-03449

INCIDENCE OF FAECAL COLIFORM AND ESCHERICHIA COLI IN FRESH FISHERY PRODUCTS.
Cochin Univ. of Science and Technology (India). School of Marine Sciences.
For primary bibliographic entry see Field 5B.
W90-03451

CLAY MINERALOGY OF THE SEDIMENTS OF THE ASHTAMUDY ESTUARY, WEST COAST OF INDIA.
Cochin Univ. of Science and Technology (India). School of Marine Sciences.
For primary bibliographic entry see Field 2J.
W90-03454

FINDINGS OF TRIBUTYLTIN, DIBUTYLTIN AND MONOBUTYLTIN IN BIVALVES FROM SELECTED U.S. COASTAL WATERS.
Battelle Ocean Sciences, Duxbury, MA.
For primary bibliographic entry see Field 5B.
W90-03459

MEASURING THE ACUTE TOXICITY OF ESTUARINE SEDIMENTS.
Oregon State Univ., Newport. Hatfield Marine Science Center.
For primary bibliographic entry see Field 5C.
W90-03465

SOME EFFECTS OF THE CYCLONES DOMOINA AND IMBOA ON MANGROVE COMMUNITIES IN THE ST LUCIA ESTUARY.
Durban-Westville Univ. (South Africa). Dept. of Botany.
For primary bibliographic entry see Field 2B.
W90-03474

TRANSPORT OF RIVER-DERIVED TRACE METALS THROUGH THE COASTAL ZONE.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia). Marine Chemistry Div.
For primary bibliographic entry see Field 5B.
W90-03481

INPUT OF SELECTED CHLORINATED HYDROCARBONS INTO THE COASTAL AREA OF EAST JAVA AND ADJACENT WATERS: DISTRIBUTION PATTERNS IN THE DISSOLVED AND SUSPENDED PHASE.
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 5B.
W90-03482

TRACE OXYANIONS AND THEIR BEHAVIOR IN THE RIVERS PORONG AND SOLO, THE JAVA SEA AND THE ADJACENT INDIAN OCEAN.
Netherlands Energy Research Foundation ECN, Petten.
For primary bibliographic entry see Field 5B.
W90-03483

DISTRIBUTION OF DISSOLVED AND PARTICULATE MINOR AND MAJOR ELEMENTS IN THE RIVER AND COASTAL ENVIRONMENT OF EAST JAVA DURING THE SNELLIUS-II EXPEDITION.
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 2K.
W90-03484

HEAVY METALS (CU, ZN, CD, PB) IN SEDIMENT OF THE JAVA SEA, ESTUARINE AND COASTAL AREAS OF EAST JAVA AND SOME DEEP-SEA AREAS.
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 5B.
W90-03485

COPPER, ZINC AND CADMIUM IN BENTHIC ORGANISMS FROM THE JAVA SEA AND ESTUARINE AND COASTAL AREAS AROUND EAST JAVA.
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 5B.
W90-03486

CYCLIC ORGANOCHLORINES IN EPIBENTHIC ORGANISMS FROM COASTAL WATERS AROUND EAST JAVA.
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 5B.
W90-03487

DISPERSAL AND DEPOSITION OF RIVER SEDIMENTS IN COASTAL SEAS: MODELS FROM ASIA AND THE TROPICS.
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 2J.
W90-03488

PATTERN ANALYSIS OF ORGANIC COMPONENT ABUNDANCES FROM DELTAIC AND OPEN MARINE DEPOSITS: PALYNOFACIES DISTRIBUTION (EAST JAVA, INDONESIA).
Utrecht Rijksuniversiteit (Netherlands). Lab. of Palaeobotany and Palynology.
I. M. Van Waveren.
Netherlands Journal of Sea Research NJSRBA, Vol. 23, No. 4, p 441-447, August 1989. 2 fig, 4 tab, 5 ref. Netherlands Foundation for Advancement of Tropical Research No. W-75-258.

Descriptors: *Sedimentation, *Indonesia, *Marine sediments, *Organic matter, *Palynology, Sediment distribution, Statistical analysis, Cluster analysis, Reciprocal averaging.

Eleven types of organic debris and thirty-one types of discrete organisms have been recognized in the surface samples obtained during research activities in Indonesia. The relative concentrations of these types have been submitted to reciprocal averaging and to cluster analysis. Applying this statistical approach to the constituents of organic matter allows the recognition of three marine depositional environments. The first is not directly affected by the terrigeneous organic matter. In the other two, two buoyancy levels (indicated by different abundances of small particles) could be recognized. Furthermore this approach suggests the presence of two other more restricted depositional environments (a wave-affected area and a near-shore area, not directly influenced by fresh water). The clustering suggests that other depositional environments might be detected. (Author's abstract)
W90-03489

SOFT-BOTTOM BENTHIC COMMUNITY IN THE ESTUARINE WATERS OF EAST JAVA.
Indonesian Inst. of Sciences, Djakarta. Centre for Research and Development in Oceanology.
W. Kastoro, I. Aswandy, I. Al Hakim, P. A. W. J. De Wilde, and J. M. Everaarts.
Netherlands Journal of Sea Research NJSRBA, Vol. 23, No. 4, p 463-472, August 1989. 2 fig, 4 tab, 21 ref.

Descriptors: *Indonesia, *Java, *Benthic fauna, *Estuarine environment, Porong River, Wonokromo River, Solo River, Biomass, Density, Species diversity, Mollusks, Polychaetes, Bioindicators.

During the Snellius-II Expedition, both in the period July-August and in the period November-December 1984, the structure of the macrobenthic communities in the estuaries of the rivers Porong, Wonokromo and Solo was investigated. The numerical densities of the benthic organisms (>0.5 mm) from the Porong, Wonokromo, and Bengawan Solo estuaries during the Snellius-II Expedition varied between 0.4 and 602 g DW/sq m. The high numerical density (1573 ind/sq m) found at st. 2 of the Porong estuary in period I (July-August 1984) was attributed to the dense population of the bivalve Varicorbula rotalis. Consequently a very high biomass (602 g DW/sq m) was measured at this station. The mollusc Theora lata and the polychaetes Ancistrosyllis parva, Nepthys dibranchis, Paraprionospio pinnate, and Sternaspis laevis occurred at almost every station during the investigation periods. Paraprionospio pinnata and Theora lata, which are considered indicator species of disharmonic environments, were found at almost every station of the study areas in both periods. Species diversity at all the stations was low, ranging from 0.1 to 1.6. (Author's abstract)
W90-03490

REMOTE SENSING OF WATER PARAMETERS IN MAJURA BAY.
Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Oberpfaffenhofen (Germany, F.R.).
For primary bibliographic entry see Field 7B.
W90-03491

BUOYANT RIVER PLUMES AND MUD DEPOSITION IN A RAPIDLY EXTENDING TROPICAL DELTA.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
For primary bibliographic entry see Field 2J.
W90-03492

SUPPLY AND DISPERSION OF WATER AND SUSPENDED MATTER OF THE RIVERS SOLO AND BRANTAS INTO THE COASTAL WATERS OF EAST JAVA, INDONESIA.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
For primary bibliographic entry see Field 2J.
W90-03493

PLANKTONIC NITROGEN TRANSFORMATIONS DURING A DECLINING CYANOBACTERIA BLOOM IN THE BALTIC SEA.
Goeteborg Univ. (Sweden). Dept. of Marine Microbiology.
E. Sahlsten, and F. Sorensson.
Journal of Plankton Research JPLRD9, Vol. 11, No. 6, p 1117-1128, November 1989. 4 fig, 1 tab, 35 ref. Nat. Swedish Environ. Protection Board grant 5312072-1.

Descriptors: *Phytoplankton, *Nitrogen, *Baltic Sea, *Cyanophyta, *Algal blooms, Radioisotopes, Eutrophication, Organic compounds, Ammonium, Ureas, Nitrates, Carbon, Salinity.

The uptake of 15N-labelled nitrogen nutrients (ammonium, urea, nitrate) was studied during the decline of a bloom of nitrogen-fixing cyanobacteria in the Baltic Sea. This was done by sampling a north-south transect of stations, representing different stages of the bloom. Comparison with nitrogen fixation data showed that this process was of minor importance, and that the nitrogen uptake was dominated by regenerated nitrogen, mainly ammonium. From time series incubations for studying nutrient uptake, it appears that the regeneration of ammonium was substantial, but that the production of urea or nitrate was slow. The integrated daily uptake was calculated for the 5 m interval at four stations and values ranged between 6 and 21 mmol N/sq m/day, of which the regenerated nutrients, ammonium and urea, constituted 71-93%. Nitrate was of minor importance and the highest nitrate uptake rates were found close to the thermocline (at 15 m) and in the southern part of the Baltic. Comparison with carbon fixation data reported from simultaneous measurements at two stations gave C/N uptake ratios of 4.9 and 2.1 for integrated daily uptake. Contrary to earlier findings, the concentration of dissolved organic nitrogen (DON) increased with increasing salinity (from 15 to 17 micromol/L). This was correlated with the declination of the bloom and is suggested to be a result of a gradual release of less easily utilized DON from the degradation of cyanobacteria. The C/N ratio of dissolved organic matter was high, 21-23. (Author's abstract)
W90-03529

PELAGIC ORGANIC MATTER IN THE ADRIATIC SEA IN RELATION TO WINTER HYDROGRAPHIC CONDITIONS.
Marine Biological Station, Piran (Yugoslavia).
J. Faganeli, M. Gacic, A. Malej, and N. Smodlaka.
Journal of Plankton Research JPLRD9, Vol. 11, No. 6, p 1129-1141, November 1989. 6 fig, 1 tab, 40 ref.

Descriptors: *Adriatic Sea, *Chlorophyll a, *Organic carbon, *Nitrogen, *Primary productivity, Ocean circulation, Zooplankton, Spatial distribution, Nutrients, Yugoslavia, Italy.

The spatial distribution of chlorophyll a (Chla), particulate organic carbon (POC) and nitrogen (PON), net zooplankton ash-free dry weight (AFDW), dry weight (DW) and carbon and nitrogen content, in parallel with primary production, was studied during a joint Yugoslav cruise in January 1980. The results were interpreted in relation to hydrographic properties, with special emphasis on the relationship between pelagic parameters. Spatial distribution of POC, PON and net zooplankton AFDW and C and N contents showed similarities over the major part of the Adriatic, while Chla and POC showed dissimilarities since higher Chla values were restricted to the north-western part of the Adriatic separated from the rest of the Adriatic by a pronounced thermal front extending south of the Istrian peninsula. High POC

was found in the center of the south Adriatic gyre and in the Jabuka Pit. The Jabuka Pit was filled with cold water originating from the area located south of the thermal front. The areas of high POC were characterized by a higher POC recycling time than in other Adriatic regions. High Chla, POC, PON and net zooplankton AFDW and C and N contents in parallel with increased primary production were found in the southwestern part of the Adriatic off Puglia (Italy) that is affected by a continuous terrigenous supply of nutrients. The observed spatial distribution pattern of pelagic organic matter suggests that this distribution is mostly influenced by hydrographic conditions and that the assumption of permanent productivity zones in the Adriatic is not applicable to the winter situation. (Author's abstract)
W90-03530

WINTER-SPRING VARIABILITY OF SIZE-FRACTIONED AUTOTROPHIC BIOMASS IN CONCEPCION BAY, CHILE.
Pontificia Univ. Catolica de Chile, Talcahuano. Dept. de Oceanografia.
H. Gonzalez, S. Pantoja, J. L. Iriarte, and P. A. Bernal.
Journal of Plankton Research JPLRD9, Vol. 11, No. 6, p 1157-1167, November 1989. 3 fig, 3 tab, 23 ref. Grants DIUC 198/84 and FONDECYT 646/87.

Descriptors: *Chile, *Phytoplankton, *Marine biology, *Chlorophyll a, Concepcion Bay, Biomass, In vivo fluorescence, Diatoms, Seasonal variation, Water depth.

The temporal variability of size-fractioned autotrophic biomass at three depth levels (1,8 and 25 m) was studied during the winter-spring transition at two oceanographic stations in Concepcion Bay. Size spectra were obtained on eight occasions by two different methods: (1) determining the biomass of seven autotrophic size fractions by in vivo fluorescence; and (2) measuring the filament length of chain-forming diatoms through direct microscopy. A clear vertical gradient of biomass was found in all profiles, with maximum values in the surface layer (1 and 8 m levels). Values of chlorophyll were on average 6.2 (range 1.08-25.67) times higher at 1 m than at 25 m, and 7.4 (range 1.15-26.83) times more at 8 m than at 25 m. On a temporal basis, total biomass increased from low average values in winter (2.5 mg chl-a/cu m) to high values in late spring (11.6 mg chl-a/cu m). During the whole sampling period (June 8-November 19), the nano-plankton and net-plankton (1.8-40 microm and 40-335 microm size fractions respectively) were more abundant near the surface (1 and 8 m depth) than close to the bottom (25 m depth); however, the picoplankton fraction (<1.8 microm) showed an inverse relationship, with a slight trend to increase near the bottom toward spring. The highest absolute biomass was concentrated in the net-plankton fraction during the whole period and the relative importance of the picoplankton decreased from winter (6.50 and 15.5% for shallow and bottom levels) to spring (1.5 and 10.3% for shallow and bottom levels). This relative effect is caused by the higher absolute values of biomass observed in the net-plankton fraction toward spring. These changing patterns should have an impact in the size-composition and abundance of higher trophic levels, mainly through grazing, in particular by modifying food availability to microflagellates, ciliates and filter-feeding zooplankton. (Author's abstract)
W90-03531

PHYTOPLANKTON SPECIES AND ABUNDANCE IN RESPONSE TO EUTROPHICATION IN COASTAL MARINE MESOCOSMS.
Rhode Island Univ., Narragansett. Marine Ecosystems Research Lab.
C. Oviatt, P. Lane, F. French, and P. Donaghay.
Journal of Plankton Research JPLRD9, Vol. 11, No. 6, p 1223-1244 November 1989. 10 fig, 5 tab, 43 ref. EPA Cooperative Agreement 810265 and NOAA Grants 83-ABD-00008 and 81-RAC-00152.

Descriptors: *Eutrophication, *Phytoplankton, *Marine algae, Nutrients, Diatoms, Dinoflagel-

lates, Flagellates, Monads, Protozoa, Species diversity, Size, Abundance.

In a mesocosm nutrient enrichment experiment the species (or categories) and abundances of diatoms, dinoflagellates, flagellates, monads and ciliates were identified and counted over a 16-month period. Diatoms and ciliates increased with increasing nutrient treatment while monads and flagellates, < 10 microm in size, did not. However, in the field, diatoms sometimes appeared to decrease while small phytoplankton < 10 microm appeared to increase under eutrophic conditions. In the experiment, in some instances, grazing controlled abundances to low levels in nutrient-enriched treatments. Self-shading by phytoplankton limited upper levels of abundance when nutrients were excessive. While nuisance species were occasionally present in various nutrient treatments, the intensity and frequency of their presence did not tend to increase with nutrient treatment. Generally species (or categories) did not appear to change with nutrient treatment, and no differences in species due to eutrophication were detected. (Author's abstract)
W90-03534

PHYTOPLANKTON STUDIES IN THE FJORDS OF WEST SPITZBERGEN: PHYSICAL ENVIRONMENT AND PRODUCTION IN SPRING AND SUMMER.
Tromsoe Univ. (Norway). Inst. of Fisheries.
H. C. Eilertsen, J. P. Taasen, and J. M. Weslawski.
Journal of Plankton Research JPLRD9, Vol. 11, No. 6, p 1245-1260, November 1989. 6 fig, 7 tab, 36 ref.

Descriptors: *Norway, *Phytoplankton, *Fjords, Primary productivity, Seasonal variation, Species diversity, Chemical analysis, Chlorophyll a.

The phytoplankton in the fjords of West Spitzbergen was investigated from 1978 to 1985. Sub-surface vertical attenuation was calculated on basis of measurements of scalar irradiance down to 50 m. Nitrate, orthophosphate, silicate, and chlorophyll a were analyzed, and carbon assimilation experiments were conducted using C14. Culture experiments with 11 arctic phytoplankton species showed that all species had significantly increased growth rates at increased daylengths. Carbon assimilation measurements from Smeerenburgfjorden showed that carbon uptake during the night amounted to 50% of uptake during the day. Measurements from the Atlantic Barents Sea south to Spitzbergen has shown that uptake during the night increases the critical depth compared to areas further south. The spring bloom lasted longer than at the Norwegian coast: from mid March to early June. There is no delay in the onset of the spring bloom in Spitzbergen fjords relative to fjords of northern Norway. This is probably related to the rapid daylength increase at high latitudes. The phytoplankton species composition during spring was comparable to that along the coast of northern Norway. Annual primary production in the investigated area was calculated to be 50 g C/sq m/year. (Author's abstract)
W90-03535

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3C. Use Of Water Of Impaired Quality

EFFECTS OF THE APPLICATION OF WASTEWATER FROM OLIVE PROCESSING ON SOIL NITROGEN TRANSFORMATION.
Estacion Experimental del Zaidin, Granada (Spain). Dept. de Quimica Agricola.
For primary bibliographic entry see Field 5D.
W90-02834

MULCH AND IRRIGATION PLACEMENT EFFECTS OF SOIL CHEMISTRY PROPERTIES

AND RABBITEYE BLUEBERRY PLANTS IRRIGATED WITH SODIC WATER.
Agricultural Research and Extension Center, Overton, TX.
K. D. Patten, E. W. Neuendorff, A. T. Leonard, and V. A. Haby.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 113, No. 1, p 4-8, Jan 1988. 5 tab, 26 ref.

Descriptors: *Irrigation effects, *Soil chemistry, *Berry crops, *Sodic water, *Irrigation design, *Drip irrigation, *Spray irrigation, *Mulching, *Salinity, *Impaired water use, Sodium compounds, Acidic soils, Crop production.

Irrigation of rabbiteye blueberries in the southerncentral acid soil regions of the United States is essential for plant establishment due to variable distribution of rainfall. One frequently available source of irrigation water in adequate quantities is deep wells, which contain high levels of Na and HCO3. Reduced plant growth and nutritional imbalances in blueberries result from irrigation with this water of marginal quality. 'Tifblue' rabbiteye blueberry (Vaccinium ashei Reade) plants were grown for 3 years under a sodic irrigation regimen. Mulched and non-mulched plants were irrigated by one of three methods: one drip emitter at the base of the plant, two drip emitters on either side of the plant, or low-volume spray emitter (LVSE). There was a mulch x irrigation treatment interaction. Mulch increased the growth of drip-irrigated plants but not LVSE-irrigated plants. Salt-induced leaf chlorosis and necrosis was only evident on plants with no mulch and irrigated with two emitters. Under mulched soil, K, Na, Mg, Cl, electrical conductivity (EC sub e), and Na adsorption ratio (SAR) levels were several times lower and uniform throughout the soil profile compared to the non-mulched treatments. Maximum root-zone salinity was 3.7 dS/m for two emitters without mulch and a minimum of 0.5 dS/m for one emitter with mulch. Several factors may account for the beneficial effect of mulch on blueberry plant growth observed in this experiment. Mulch increased the spread of the wetting front from drip emitters. This increase was especially important for the two emitter per plant treatment. Without mulch, the wetting front pattern from two emitters was not wide enough to allow sufficient water to reach young plants. It appears that marginal quality water can be used successfully on rabbiteye blueberries if the soil matric potential at the root zone is maintained between 10 and 20 kPa, and EC sub e at the root zone is kept below 1.5 dS/m. (Author's abstract)
W90-03229

IRRIGATION WATER QUALITY.
Virginia Polytechnic Inst. and State Univ., Blacksburg.
B. B. Ross.
Grounds Maintenance, Vol. 23, No. 8, p 74-78, August 1988.

Descriptors: *Soil water, *Water quality, *Drought effects, *Drought, *Irrigation water, *Irrigation effects, *Soil physical properties, *Soil porosity, Sodium, Boron, Chlorides, Clays, Impaired water use, Bicarbonates, Lime, Drainage, Calcium, Magnesium, Gypsum, Soil chemistry.

During an extended drought, potential water quality problems may surface. Water quality problems that affect irrigation equipment operation usually result from particulate matter, such as sand, silt and organic material. Plants may be affected by dissolved salts, such as boron and chloride, that may be present in concentrations high enough to result in direct plant toxicity. High concentrations of sodium may result in its adsorption by the clay particles in the soil. The clay then disperses, clogging soil pores and reducing permeability. Water that is high in bicarbonate may aggravate the sodium problem, causing the calcium and magnesium to precipitate out as lime and increasing the effective sodium percentage of the water. Adequate internal drainage is most important when dealing with poor quality irrigation water. Adequate subsurface drainage is needed as well. Another approach to a single insufficient supply of

good-quality water is to blend two or more sources of varying quality. If it comes down to reclaiming sodic soils, leaching alone may not remove sodium from the root zone. It may be necessary for you to apply gypsum to the soil to release the sodium from soil particles. Follow the gypsum application by intense leaching, either by irrigation or rainfall, to flush sodium from the root zone. (Mertz-PTT) W90-03273

IRRIGATION METHOD AND WATER QUALITY EFFECT ON PEANUT YIELD AND GRADE.
Agricultural Research Service, Suffolk, VA.
For primary bibliographic entry see Field 3F.
W90-03276

SALINITY EFFECTS ON RYE GRAIN YIELD, QUALITY, VEGETATIVE GROWTH, AND EMERGENCE.
Agricultural Research Service, Riverside, CA. Salinity Lab.
L. E. Francois, T. J. Donovan, K. Lorenz, and E. V. Maas.
Agronomy Journal AGJOAT, Vol. 81, No. 5, p 707-712, Sep/Oct 1989. 2 fig, 4 tab, 20 ref.

Descriptors: *Saline soils, *Crop yield, *Plant growth, *Impaired water use, *Grain crops, *Irrigation effects, *Saline water, *Salt tolerance, *Rye, Arid lands, Silt, Clays, Irrigation water.

Although current rye (Secale cereale L.) grain production is concentrated mainly in the northern half of the USA and Canada, some rye grain is grown in the arid southwest. Soils in this area are, or have the potential to become, highly saline from the application of saline irrigation water. Since there is nearly a complete lack of information about the response of rye grown under saline conditions, a 2-yr field plot study was conducted. Six salinity treatments were imposed on a Holtville silty clay by irrigating with Colorado River water artificially salinized with NaCl and CaCl2 (1:1 by weight). Electrical conductivities of the irrigation waters were 1.1, 4.0, 8.0, 12.1, 16.0, and 20.1 dS/m the first year, and 1.1, 3.9, 7.5, 11.6, 15.6, and 19.8 dS/m the second year. Grain yield and vegetative growth were measured. Relative grain yield of two cultivars, Maton and Bonel, was unaffected up to a soil salinity of 11.4 dS/m. Each unit increase in salinity above 11.4 dS/m reduced yield by 10.8%. These results place rye in the salt-tolerant category. Yield reduction was attributed primarily to reduced spike weight and individual seed weight rather than spike number. Bread quality decreased slightly with increasing levels of salinity. Straw yield was more sensitive to salinity than was grain yield. Plant emergence was determined in greenhouse sand cultures. Both cultivars were slightly less tolerant during plant emergence than during subsequent stages of growth. (Author's abstract) W90-03280

SALINE IRRIGATION REGIME FOR IMPROVING TOMATO FRUIT QUALITY WITHOUT REDUCING YIELD.
Ben-Gurion Univ. of the Negev, Beersheba (Israel). Boyko Inst. for Agriculture and Applied Biology.
Y. Mizrahi, E. Taleisnik, V. Kagan-Zur, Y. Zohar, and R. Offenbach.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 113, No. 2, p 202-205, Mar 1988. 6 tab, 11 ref.

Descriptors: *Impaired water use, *Irrigation practices, *Drip irrigation, *Crop yield, *Tomatoes, *Saline water, *Seawater, Market value, Greenhouses, Sand, Flavor, Color, Fruit size.

Tomato (Lycopersicon esculentum Mill 'FC111') plants were drip irrigated with two different concentrations of diluted seawater (3 or 6 dS/m) applied at appearance of the first true leaf (early) or at first breaker fruit (late) stages of plant development. In general, salinity improved flavor and increased percent total soluble solids and sugar concentration. It also reduced color flaws, thus improving the overall quality of fruit. Shelf life was

not affected by saline treatments, whereas the yield and fruit size were generally lower than those of fruit from the control treatment. The most important findings were that the overall yield of plants irrigated with the low concentration of saline water at the late stage of development was not significantly different from that of control plants; export quality yield was the same, while fruit quality was still significantly better than that of the control. The use of saline water for quality improvement of tomato fruit grown on sand dunes under glasshouse conditions is thus feasible. (Author's abstract) W90-03317

NUTRITION AND YIELD OF YOUNG APPLE TREES IRRIGATED WITH MUNICIPAL WASTE WATER.
Agriculture Canada, Summerland (British Columbia). Research Station.
For primary bibliographic entry see Field 3F.
W90-03364

USE OF SEWAGE SLUDGE AS SOIL AMENDMENT: EFFECT ON YIELD OF FORAGE AND SOIL CHEMICAL PROPERTIES.
Puerto Rico Univ., Mayaguez. Dept. of Agronomy and Soils.
For primary bibliographic entry see Field 5E.
W90-03547

3E. Conservation In Industry

EFFECTS OF IRRIGATED AGRICULTURE ON GROUNDWATER QUALITY IN CORN BELT AND LAKE STATES.
Fuller, Mossbarger, Scott and May, Lexington, KY.
W. A. Mossbarger, and R. W. Yost.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 115, No. 5, p 773-790, October 1989. 13 fig, 2 tab, 13 ref.

Descriptors: *Water pollution sources, *Groundwater pollution, *Water quality, *Wisconsin, *Agricultural hydrology, *Groundwater quality, *Irrigation effects, *Agricultural chemicals, Sand, Soil moisture retention, Domestic water, Rural areas, Climates, Topography, Geology, Geohydrology, Soil types, Agriculture, Cropland, Crop yield, Hydraulic conductivity, Nitrates, Pesticides, Case studies, Corn Belt, Aldicarb.

Only recently has attention been focused on the possible impacts of agricultural irrigation on groundwater quality. This is of particular concern because groundwater is the predominant source of domestic water in most rural areas. The impact of irrigation on groundwater quality is influenced by climate, topography, geology, soils, geohydrology, crops, and agricultural practices. Since the early 1950s, the irrigated crop acreage in the Corn Belt and Lake States has increased markedly. Irrigation in these regions is concentrated in areas underlain by sandy soils with low moisture-holding capacities, where supplemental moisture and relatively heavy applications of agrichemicals are needed to achieve economically viable crop yields. Due to the high hydraulic conductivities and low attenuation capacities of sandy soils, shallow aquifers underlying these areas are particularly susceptible to contamination with nitrates and stable, soluble pesticides. Present and potential problems associated with irrigation in these states are illustrated by available case studies of aldicarb and nitrate contamination in the Central Sand Plain of Wisconsin. (Author's abstract) W90-02569

3F. Conservation In Agriculture

IRRIGATED AGRICULTURE AND WATER QUALITY IN SOUTH.
Maryland Univ., College Park. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W90-02570

IRRIGATED AGRICULTURE AND WATER QUALITY IN EAST.
Delaware Univ., Newark. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W90-02571

IRRIGATION IMPACT ON GROUNDWATER: MODEL STUDY IN HUMID REGION.
Agricultural Research Service, Tifton, GA. Southeast Watershed Research Center.
For primary bibliographic entry see Field 5B.
W90-02572

CENTER-PIVOT END GUN IRRIGATION COST ANALYSIS.
Louisiana State Univ., Baton Rouge. Dept. of Agricultural Engineering.
R. J. Edling.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 115, No. 5, p 853-861, October 1989. 4 fig, 2 tab, 11 ref.

Descriptors: *Cost analysis, *Irrigation efficiency, *Irrigation engineering, *Sprinkler irrigation, *Water conveyance, Conveyance structures, Water distribution, Agricultural engineering, Sprinklers, Energy loss, Water pressure, Water delivery, Head loss, Flow regulators.

Center-pivot system laterals with end part-circle large volume sprinklers are commonly used in irrigational systems. These sprinklers operate as the lateral passes through the corners of square fields. An analysis was performed to quantify the energy required to deliver pressure head for the area irrigated by an end gun. The energy actually used to apply water to the corner while the end gun was on and the extra energy used while the end gun was off were estimated. With the end gun off there is increased application of water under the lateral. Energy use associated with this increased application was estimated. The pressure head cost ratio (with end gun/without end gun) was in direct proportion to the capacity ratio (end gun/total system). The values ranged from a cost ratio of 1.73 for a capacity ratio of 0.05 to 3.69 for a capacity ratio of 0.20. Speed modification and flow-pressure regulation with the end gun off were also considered. Energy reduction was not significant for these modifications. (Author's abstract) W90-02574

OPTIMAL SCHEDULING OF IRRIGATION MACHINES. I: MODEL DEVELOPMENT.
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
I. Broner, and J. Lambert.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 115, No. 5, p 862-879, October 1989. 7 fig, 3 tab, 21 ref.

Descriptors: *Irrigation programs, *Irrigation scheduling, *Model studies, *Farming, *Computer models, *Irrigation efficiency, *Agricultural engineering, *Scheduling, Decision making, Water distribution, Irrigation practices, Humid areas, Crop yield, Corn, Growth rates, Simulation analysis, Mathematical models, Optimization, Fortran, Water allocation, Water resources development.

Farmers face increasingly complex problems of decision making. Irrigation scheduling is the decision of when and how much water to apply. An irrigation scheduling model for a center-pivot irrigation machine was developed to maximize returns in humid areas. A corn growth-simulation and yield-simulation model was incorporated to predict the end-of-season yield. The irrigation decision process for an irrigation machine was defined and formulated mathematically into a model that sequentially optimizes the irrigation schedule. The problem of optimal scheduling of an irrigation machine was divided into a single-field problem and a multifield problem. Each problem was formulated as a decision-tree problem and was solved using tree enumeration techniques. The model was coded into a computer program written in PASCAL that uses the corn simulation model

(written in FORTRAN) as a subroutine. The model can aid in making the daily irrigation decision and the allocation of limited water resources when irrigating different fields under the same center-pivot machine. (Author's abstract)
W90-02575

OPTIMAL SCHEDULING OF IRRIGATION MACHINES. II: APPLICATIONS AND RESULTS.
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
I. Broner, and J. Lambert.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 115, No. 5, p 880-893, October 1989. 1 fig, 11 tab, 3 ref.

Descriptors: *Irrigation programs, *Irrigation scheduling, *Model studies, *Farming, *Irrigation efficiency, *Agricultural engineering, *Scheduling, Decision making, Water distribution, Irrigation practices, Humid areas, Arid-zone hydrology, Field tests, Crop yield, Corn, Rainfall, Simulation analysis, Mathematical models, Optimization, Case studies, Water allocation, Water resources development.

Scheduling of irrigation machines in humid areas is considerably more complicated than scheduling of solid-set systems or scheduling irrigations in arid areas. Consideration should be given to the time it takes to complete a full irrigation cycle, to avoid water stress in field sectors, as well as to probable rains during the scheduling period, to avoid over-watering. A short-range irrigation-scheduling model for center-pivot machines sequentially optimizes the irrigation schedule to maximize net return from a center-pivot irrigation machine. Application of the model was done by using field experiments conducted in previous years and by conducting an initial field experiment. After-the-fact simulation of the irrigation-decision process using the optimal model was done for the field experiments conducted in previous years, and the results were compared with the actual field results. In the field experiment, the optimal scheduling model was compared with a conventional irrigation-scheduling method. The net return from corn under a simulated center-pivot system was increased by 7.8% over the conventional scheduling method and 10.1% over no irrigation. It was concluded that the model can aid the daily irrigation decision and the allocation of limited water supplies among competing crops under the same irrigation machine. (Author's abstract)
W90-02576

INFLUENCE OF PLASTIC MULCH AND TYPE AND FREQUENCY OF IRRIGATION ON GROWTH AND YIELD OF BELL PEPPER.
Long Island Horticultural Research Lab., Riverhead, NY. Dept. of Vegetable Crops.
J. E. VanDerwerken, and D. Wilcox-Lee.
Hortscience HJHSAR, Vol. 23, No. 6, p 985-988, Dec 1988. 1 fig, 2 tab, 12 ref.

Descriptors: *Irrigation, *Irrigation practices, *Irrigation efficiency, *Mulching, *Crop yield, Pepper plants, Plastic mulch, Trickle irrigation, Sprinkler irrigation.

A field study was designed to evaluate the effects of various irrigation methods, raised beds, and plastic mulch on yield and fruit quality of bell pepper (Capsicum annuum L.). Irrigation was scheduled on the basis of soil matric potential and monitored by Hg manometer tensiometers and soil moisture blocks. Trickle-irrigated plots were watered at soil matric potentials of -0.025 and -0.075 MPa, and sprinkled plots at -0.075 MPa. The combination of black polyethylene mulch and irrigation produced maximum yields, but frequency of irrigation had little effect on yield when peppers were mulched. High frequency trickle irrigation (irrigated 15 x) and trickle irrigation of a lesser frequency (irrigated 5 x) resulted in similar yields when peppers were mulched. The use of mulch without irrigation had a large effect on yield: yields from plots that were mulched but not irrigated were similar to yields from plots that were sprinkler-irrigated but not mulched. The percent-

age of marketable fruit was substantially reduced in the absence of irrigation or mulch because of the high incidence of both solar injury and blossom-end rot. (Author's abstract)
W90-02740

WATER MANAGEMENT DURING TALL FESCUE ESTABLISHMENT.
Colorado State Univ., Fort Collins. Dept. of Horticulture.
J. D. Fry, and J. D. Butler.
Hortscience HJHSAR, Vol. 24, No. 1, p 79-81, Feb 1989. 2 tab, 7 ref.

Descriptors: *Irrigation, *Irrigation efficiency, *Irrigation requirements, Soil moisture retention, Tall fescue, Germination, Hydrophilic polymers, Lysimeters.

Field and greenhouse studies were conducted to determine effects of deficit irrigation and pre-plant soil incorporation of a hydrophilic polymer on the establishment of 'Rebel' tall fescue. In the field, lysimeters containing a sandy clay loam soil were seeded with tall fescue and irrigated with equivalents of 50% or 100% of the potential evapotranspiration (ETp) (i.e., water used when soil moisture is not limiting) of a mature turf. The low irrigation level resulted in poor germination and stand establishment. Pre-plant incorporation of a hydrophilic polymer (98 kg/ha) was ineffective in enhancing seedling survival under dry soil conditions. Greenhouse studies evaluating higher levels of polymer application on tall fescue establishment during drought revealed that the polymer did not reduce plant stress until occupying at least 1.0% of the soil volume to a depth of 12.5 cm. Excessive polymer amounts would be required to achieve this proportion in the field. (Author's abstract)
W90-02742

SCHEDULING IRRIGATIONS FOR CUCUMBERS.
Colorado State Univ., Fort Collins.
J. E. Ellis, G. Kruse, and A. E. McSay.
Hortscience HJHSAR, Vol 24, No. 3, p 448-452, June 1989. 2 fig, 4 tab, 7 ref.

Descriptors: *Irrigation, *Irrigation efficiency, *Crop production, Cucumbers, Schedules, Efficiency.

Cucumber (Cucumis sativus L.) irrigation scheduling was studied for 4 years from 1983-1986. Tensiometers were used during the first year to determine when to irrigate, and the USDA irrigation scheduling program was used to determine the amount of water to apply. The data from the first year's study indicated that the plants had not been stressed; therefore, the following year, estimates of the available water depletion were made with the USDA irrigation scheduling program, with tensiometers used only for comparison. After 4 years of study, it was concluded that the best combination for high yield, best water use efficiency, and fewest number of irrigations was obtained if cucumbers were irrigated when the original scheduling program determined that 40% of the available water was depleted, and applying only 70% of the water that the program indicated was required. This indicated that the program was overestimating the rate at which water was being depleted. Therefore, as a final step, a revised set of cucumber coefficients that approximated daily evapotranspiration (ET) more closely was determined. When using the revised coefficients, cucumbers should receive the exact amount of water called for by the irrigation program. (Author's abstract)
W90-02744

SOIL WATER CONSERVATION UNDER ZERO--AND CONVENTIONAL TILLAGE SYSTEMS ON THE CANADIAN PRAIRIES.
Saskatchewan Univ., Saskatoon. Saskatchewan Inst. of Pedology.
M. C. Grevers, J. A. Kirkland, E. De Jong, and D. A. Rennie.
Soil and Tillage Research SOTRD5, Vol. 8, No. 1-4, p 265-276, Nov 1986. 4 fig, 4 tab, 8 ref.

Descriptors: *Agricultural hydrology, *Soil water, *Water conservation, *Cultivation, Canada, Nitrogen, Soil water balance, Crop yield, Tillage.

The soil water balance under different tillage systems and the effect of spring nitrogen and water levels on crop yields in the Canadian Prairies was investigated. Results from 12 site-years indicate that soil water recharge during the autumn to seeding period was greater under zero tillage than under conventional tillage, probably due to reduced soil water evaporation during the period from snow-melt to seeding. Water use efficiency was 49.7 kg/ha wheat per cm water under conventional tillage. Under zero tillage, water use efficiencies varied with soil texture, ranging from 53.7 to 186 kg/ha wheat per cm water for loam and heavy clay, respectively. Wheat yield was well correlated with both available nitrogen and water content in spring. Nitrogen was more limiting under zero tillage than under conventional tillage. The crop response to available nitrogen was two times greater under zero tillage compared with conventional tillage. Soil water was more limiting under conventional tillage than under zero tillage. The crop response to soil moisture content was four times greater under conventional tillage compared with zero tillage. Soil water depletion during the growing season essentially followed the same pattern under both tillage systems. (Author's abstract)
W90-02774

TILLAGE AND RAINFALL EFFECTS ON RANDOM ROUGHNESS: A REVIEW.
Agricultural Research Service, Big Spring, TX.
T. M. Zobeck, and C. A. Onstad.
Soil and Tillage Research SOTRD5, Vol. 9, No. 1, p 1-20, Jan 1987. 9 tab, 70 ref.

Descriptors: *Soil erosion, *Cultivation, *Soil surfaces, Tillage, Soil texture, Model studies, Rainfall.

Soil microrelief, or roughness, as a result of tillage can have considerable impact on the rate and amount of wind and water erosion. This study is a review and analysis of previous studies dealing with factors associated with the formation of tillage-induced random (non-oriented) roughness of the soil surface. Soil roughness has long been measured with microrelief meters where individual elevations of the soil surface are measured at points. Such meters have been labor intensive, but advances in electronics and sensing have minimized that problem. Random roughness (RR) has been defined as the standard error of individual elevations after oriented roughness has been removed. In addition to being a function of the soil and its properties, RR is affected by tillage and rainfall. A model predicting changes in random roughness with changes in tillage and rainfall amount is proposed. Random roughness varied from 5.0 cm for a large offset disk operation to 0.7 cm for no-till systems and decreased exponentially with increasing rainfall. The proposed model will make a significant contribution to new models, currently under development, to predict the effects of wind and water erosion on soil movement. (Author's abstract)
W90-02775

FALLOW METHOD INFLUENCES ON SOIL WATER AND PRECIPITATION STORAGE EFFICIENCY.
Agricultural Research Service, Sidney, MT. Northern Plains Soil and Water Research Center.
D. L. Tanaka, and J. K. Aase.
Soil and Tillage Research SOTRD5, Vol. 9, No. 4, p 307-316, Jul 1987. 1 fig, 8 tab, 16 ref.

Descriptors: *Cultivation, *Soil water, *Mulches, Fallowing, Rainfall, Water storage, Seasonal variation, Water depth, Wheat.

Summer fallowing is practiced in the Great Plains of the U.S.A. in order to store soil water, control weeds, make nutrients available and stabilize crop yields. Soil water storage and precipitation storage efficiencies on chemical and stubble-mulch fallow plots were compared for three 14-month fallow periods for a winter-wheat-fallow rotation (Triti-

cum aestivum L.) and three 21-month fallow periods for a winter-wheat-fallow rotation in the northern Great Plains to determine during which seasonal segment the fallow method might influence soil water storage. The experiment was conducted on a glacial till Williams loam (fine-loamy mixed, Typic Argiboroll) from July 1981 to April 1985. Soil water contents to a depth of 1.70 m were measured, using the neutron scatter technique, for seasonal segments during the fallow period. Soil water storage was similar from harvest to spring on chemical and stubble-mulch fallow plots. The over-winter to spring segment resulted in the most consistent precipitation storage efficiencies (33.3-71.1%). Soil water storage differences as a result of a fallow method are most likely to occur during summer fallow for 14-month winter-wheat-fallow rotations and during the second overwinter for 21-month spring-wheat-fallow rotations. Soil water storage for the entire fallow period was greater on chemical fallow than on stubble-mulch fallow in two out of three 14-month winter-wheat fallow periods and in one out of three 21-month spring-wheat fallow periods. (Author's abstract) W90-02778

IRRIGATION EFFECTS ON WATER USE, AND PRODUCTION OF TAP ROOTS AND STARCH OF BUFFALO GOURD.
Maricopa Agricultural Center, AZ. Dept. of Plant Science.
J. M. Nelson, J. C. Scheerens, D. A. Bucks, and J. W. Berry.
Agronomy Journal AGJOAT, Vol. 81, No. 3, p 439-442, May/June 1989. 2 fig, 4 tab, 17 ref.

Descriptors: *Water use, *Irrigation effects, *Irrigation efficiency, *Plant growth, *Semiarid lands, Available water, Water use efficiency, Agronomy, Crop production, Consumptive use, Water stress.

The buffalo gourd (Cucurbita foetidissima HBK) is a possible new root starch crop for semiarid regions. Information on water use relationships of this species is needed to determine its suitability for arid lands agriculture. The objective of this study was to assess the influence of water management on buffalo gourd tap root production and water use. Five irrigation levels were evaluated for an annual buffalo gourd crop in 1985 and 1986 at a 360-m elevation field site on Casa Grande sandy loam (fine-loamy, mixed, hyperthermic Typic Natrargid) using plant populations of 400,000 to 450,000 plants/hectare. Irrigating at 50% available soil water (ASW) content (I-1) gave higher fresh tap root yields than irrigating at 75% ASW (I-2) (27.8 vs. 24.1 Mg/ha) in 1985 with identical starch yields. In 1986 the I-2 treatment was higher that the I-1 treatment in starch yield (3.1 vs. 2.1 Mg/ha) and tap root starch concentration (47.5 vs. 38.1%). Vines of water stressed plants (I-2) grew rapidly when irrigated. Consumptive water use was 649 and 487 mm in I-1 and I-2, respectively. Peak consumptive use rates were <6.5mm/day. As much as 48% of seasonal water use was from the 0 to 0.4 m depth. Water was extracted to a depth of 2.6 m. The I-2 treatment had the highest water-use efficiency (WUE), 4.9 kg/cu m, for fresh root production. The WUE for starch production was higher for the I-2 treatment (0.62 kg/cu m) than the I-1 treatment (0.42 kg/cu m). Irrigation scheduling to provide moderate stress reduces buffalo gourd water use without reducing starch yield, increasing its potential as a semiarid starch crop. (Author's abstract) W90-02829

DETRIMENTAL INTERACTION OF SUBSOIL ALUMINUM AND DROUGHT STRESS ON THE LEAF WATER STATUS OF SOYBEAN.
Wisconsin Univ.-Madison. Dept. of Agronomy.
I. L. Goldman, T. C. Carter, and R. P. Patterson.
Agronomy Journal AGJOAT, Vol. 81, No. 3, p 461-463, May/June 1989. 4 tab, 18 ref.

Descriptors: *Aluminum, *Drought, *Soybeans, *Subsoil, *Water stress, Transpiration, Leaves, Water potentials.

Drought and subsoil Al are major concerns which face soybean producers in the southeastern USA.

However, the interaction of these two factors is not clearly understood. A study was designed to characterize the combined effect of these two stress factors on soybean water status. A greenhouse experiment was conducted, with two levels of subsoil Al saturation (6 and 71%), and two levels of drought stress (watered and unwatered). A split plot experimental design with three replications was employed. Soil treatments were applied via a soil layering technique using topsoil of a Goldsboro sandy loam (fine-loamy, siliceous, thermic, Aquic Paleudult). The top layer in all pots consisted of the unamended topsoil. In the lower layer, highly contrasting Al stauration levels were obtained by amending one half of the pots with Al2(SO4)3. Data were collected during a 14-d moisture stress treatment imposed at podfilling (R3). Traits measured were leaf water potential, relative water content, transpiration, and diffusive resistance. A detrimental interaction between subsoil Al and drought was observed in all traits measured. Plants grown in the presence of both stress factors had lowered levels of leaf relative water content and water potential, and a lower transpiration rate than predicted additively by independent stress factors. In general, subsoil Al had much greater effects on leaf water status in drought-stressed soybean plants than in the well-watered plants. These results suggest that hindered root growth in highly Al-saturated subsoils may have limited the ability of the plant to withstand drought. Soybean producers in regions characterized by drought and subsoil Al should consider the incorporation of Al-tolerant germplasm into management systems. Field studies including water stress as a variable should be interpreted with regard to this innteraction, if soil Al is present. (Author's abstract) W90-02830

WATER USE EFFICIENCY AND DRY MATTER DISTRIBUTION IN NITROGEN- AND WATER-STRESSED WINTER WHEAT.
Agricultural Research Service, Stoneville, MS. Cotton Physiology and Genetics Research.
J. J. Heitholt.
Agronomy Journal AGJOAT, Vol. 81, No. 3, p 464-469, May/June 1989. 2 fig, 3 tab, 27 ref.

Descriptors: *Water use efficiency, *Nitrogen, *Water stress, *Wheat, Dry matter, Transpiration, Carbon dioxide, Root development.

Water use efficiency (WUE) and the distribution of dry matter to the roots in wheat (Triticum aestivum L.) are potential selection criteria for improving yield under water stress. The objectives of this research were (1) to compare methods of measuring WUE, and (ii) to determine the distribution of dry matter between shoots and roots in water- and N- stressed wheat. Winter wheat was grown in a potting mixture for 6 wk in growth chambers with varying levels of N and water. Nitrogen applied to the mixture varied from 10 to 100 mg N per plant. Water supply was maintained at 15 to 35% of the mixture water holding capacity (stressed) to above 50% of capacity (well watered). Cumulative transpiration, steady-state CO2 and H2O exchange rates, and dry matter were determined. The ratio of the steady state CO2 exchange rate to the H2O exchange rates was 1.97 and 4.24 mmol C per mol H2O for the 10 and 100 mg N treatments, respectively. The gas exchange WUE values tended to be higher than the gravimetric WUE values, but the two were correlated (r= 0.76). Results support the hypothesis that gas exchange WUE values could provide an accurate prediction of WUE values obtained from gravimetric analysis. Shoot:root ratio was consistently reduced by N stress, but not by water stress. The results support previous observations that optimal leaf N concentration promoted higher WUE. Mild water stress did not consistently affect WUE, but a more severe water stress consistently decreased WUE, especially under suboptimal N supply. (Author's abstract) W90-02831

NUMERICAL ASPECTS OF SIMULATION AND OPTIMIZATION MODELS FOR A COMPLEX WATER RESOURCES SYSTEM CONTROL.

Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
M. Baosic, and B. Djordjevic.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 393-398, 7 fig, 3 ref.

Descriptors: *Irrigation design, *Model studies, *Hydrologic models, *Simulation, *Optimization, *Water resources management, Mathematical models, Computer models, Performance evaluation, Differential equations, Finite element method, Computer programs.

A very complex (both hydraulically and numerically) simulation model aiming at the effective control of a water resources system (WRS) has been designed. The non-standard problems of an unsteady flow with increased number of discharge changes within a WRS (tributaries, inflows, and pumping stations for irrigation and drainage) are solved using this flow in open-channel modeling theory (Preissman scheme, Cholesky scheme, etc.). The mathematical model for unsteady was based on the solution of the Saint Venant differential equations. Preissman's finite increments implicit method with discretization was used to solve the partial differential equations. A simple programming procedure was employed to obtain the correct solution of a system of equations of quadridiagonal shape. The model provides information on the flow at various places within the WRS system and graphical output makes decisionmaking much easier. Its computational efficiency on the VAX computer was very high. If a controlling parameter value is introduced, the model can be used as an optimization model. (See also W90-03036) (Rochester-PTT) W90-03093

MULCH AND IRRIGATION PLACEMENT EFFECTS OF SOIL CHEMISTRY PROPERTIES AND RABBITEYE BLUEBERRY PLANTS IRRIGATED WITH SODIC WATER.
Agricultural Research and Extension Center, Overton, TX.
For primary bibliographic entry see Field 3C. W90-03229

CULTIVATION OF UPLAND RICE IN DREDGED ESTUARINE LAGOON SPOILS, WITH EMPHASIS ON THE CHEMICAL PROPERTIES OF THE SEDIMENT.
Tohoku Univ., Sendai (Japan). Biological Inst.
For primary bibliographic entry see Field 5E. W90-03234

IRRIGATION WATER QUALITY.
Virginia Polytechnic Inst. and State Univ., Blacksburg.
For primary bibliographic entry see Field 3C. W90-03273

CHEMIGATION: HOW IRRIGATION LINES CAN SERVE DOUBLE DUTY.
Hardie Irrigation, El Cajon, CA.
I. Bisconer.
Agricultural Engineering AGENAZ, Vol. 68, No. 4, p 8-11, May/Jun 1987.

Descriptors: *Irrigation design, *Irrigation, *Agricultural chemicals, *Fertilizers, *Herbicides, *Insecticides, *Pesticides, *Fungicides, Irrigation water, Micronutrients, Microirrigation, Nematicides, Irrigation effects, Water delivery.

Chemicals applied through micro-irrigation systems include chlorine and acid as water treatments, and water amendments such as fertilizers, micronutrients, herbicides, nematicides, fungicides, and insecticides. Combining these materials with irrigation water can improve efficiency, lower costs, boost yields, and enhance safety. In addition, chemigation through micro-irrigation systems offers considerable potential for reducing environmental contamination. An integrated design involves far more than simply injecting chemicals into a water

delivery system. The added material may cause a substantial change in fluid chemical properties and system characteristics. In turn, these changes have a pronounced effect on component selection, system design, and overall operation. (Mertz-PTT)
W90-03274

SOIL DISTURBANCE-RESIDUE MANAGEMENT EFFECT ON WINTER WHEAT GROWTH AND YIELD.
Agricultural Research Service, Lincoln, NE.
W. W. Wilhelm, B. Bouzerzour, and J. F. Power.
Agronomy Journal AGJOAT, Vol. 81, No. 4, p 581-588, Jul/Aug 1989. 6 fig, 7 tab, 26 ref.

Descriptors: *Dry farming, *Crop yield, *Mulching, *Fallowing, *Cultivation, *Wheat, *Soil management, Fertilizers, Loam, Midwestern United States, Plant growth, Soil erosion, Temperature effects, Soil water.

The need to reduce soil erosion, maximize soil water conservation, and optimize grain production in dryland cropping systems in the Central Great Plains has culminated in development of nontilled fallow systems. These systems have greatly reduced the degree of soil disturbance, and the amount and degree of residue incorporation. The objectives of this study were to evaluate the influence of soil disturbance and residue management on soil temperature, soil water, and winter wheat growth. Two field studies were established in 1981 and 1982 on an Alliance silt loam with treatments consisting of various degrees of soil disturbance, residue incorporation and amount of residue applied. Decreased soil disturbance and increased residue application decreased maximum, and increased minimum, soil temperatures. In all tillage treatments, soil water content showed a significant positive linear relationship to residue application rate. Grain yield was similar for all treatment factors, except tillage within the 1983-1984 season when tilled treatments produced more grain than the nontilled treatment. Early development and growth of winter wheat was slowed by the presence of residues or the absence of tillage. However, by completion of heading, phenology and yield were similar for all treatments. Cooler soil temperatures slowed development and growth during those stages when the meristem temperature was influenced most by soil temperature. However, after jointing, when air temperature and photoperiod were controlling development and growth, differences among treatments disappeared. Interaction of wheat development with soil temperature, air temperature, and daylength may contribute to the crop's inability to consistently capitalize, in terms of grain yield, on the greater amount of water stored in nontilled and mulched systems. (Author's abstract)
W90-03275

IRRIGATION METHOD AND WATER QUALITY EFFECT ON PEANUT YIELD AND GRADE.
Agricultural Research Service, Suffolk, VA.
F. J. Adamsen.
Agronomy Journal AGJOAT, Vol. 81, No. 4, p 589-593, Jul/Aug 1989. 4 fig, 4 tab, 17 ref.

Descriptors: *Peanuts, *Irrigation effects, *Alkaline water, *Water quality, *Crop yield, *Crop production, *Impaired water use, *Sodium, Sprinkler irrigation, Virginia, North Carolina, Trickle irrigation.

Peanut (Arachis hypogaea L.), irrigated only recently in the coastal plain region of Virginia and North Carolina, is produced in an area where sodic deep water sources are more readily available than high quality shallow water sources. The objective of this work was to determine that effect of irrigation water quality and irrigation method on the yield and grade of peanut. Virginia-type peanuts (cv. VA81B) were grown on a Kenansville loamy sand in Suffolk, VA from 1984 to 1987. Peanuts were irrigated with either overhead sprinklers or deep buried trickle lines using deep-well (142 m) and shallow-well (10 m) water. Trickle lines were buried 350 to 410 mm below each row. Deep-well water had 220 mg Na/L, a pH of 8.5, and a sodium

adsorption ratio of 103. Shallow-well water had 4.8 mg Na/L, a pH of 4.8, and an sodium adsorption ratio of 3.1. Shallow-well, trickle-irrigated peanuts yielded 5003 kg/ha or 14% higher than the nonirrigated treatment. Deep-well, sprinkler-irrigated peanuts averaged 4374 kg/ha for 4 years, which was 21 kg/ha lower than the nonirrigated treatment. The price of deep-well, sprinkler-irrigated peanuts was also lower than all other treatments due to lower percentages of extra-large kernels, total sound mature kernels, and fancy pods. Deep-well water applied below 300 mm through trickle irrigation produced peanuts of comparable quality and quantity as the shallow-well, trickle, or sprinkler-irrigation treatments. Irrigation of peanuts was beneficial in this humid region. There was no difference in peanut yield or grade when sprinkler or trickle irrigation was used with good quality irrigation water, but trickle irrigation required only 44% as much water. With a sodic water source, trickle irrigation was superior to sprinkler application. (Author's abstract)
W90-03276

CONSERVATION TILLAGE SYSTEM FOR PROFITABLE COTTON PRODUCTION IN THE CENTRAL TEXAS HIGH PLAINS.
Texas A and M System Research and Extension Center, Amarillo.
W. L. Harman, G. J. Michels, and A. F. Wiese.
Agronomy Journal AGJOAT, Vol. 81, No. 4, p 615-618, Jul/Aug 1989. 4 tab, 19 ref.

Descriptors: *Soil moisture retention, *Cotton, *Barley, *Crop production, *Texas, *Soil moisture deficiency, *Agricultural hydrology, Herbicides, Loam, Silt, Fallowing, Water scarcity, Economic aspects.

Irrigation water supplies are dwindling in the southern High Plains and effective methods of conserving precipitation during fallow periods are needed. This study was conducted to compare soil water storage, yield of cotton, and profitability of conventional and no-tillage in a 2-yr, double crop, irrigated barley (Hordeum vulgare L.)–dryland cotton (Gossypium hirsutum L.) cropping sequence with a 48 week fallow from barley harvest and cotton planting. The soil was a Sherm clay loam with 2.2% organic matter, a soil pH of 6.9, and 28% sand, 31% silt, and 41% clay. Kochia, Russian thistle, pigweed (Amaranthus blitoides S. Wats.), and witchgrass (Panicum capillare L.) were controlled during fallow with disk and field cultivator in conventional tillage. Herbicides used for no-tillage were dicamba, atrazine, fluometuron, and glyphosate. A 45 mm increase in soil water storage with no-tillage increased dryland cotton yields 110 kg/ha. Although herbicide costs were $155/ha greater with no-tillage, long-term annual profit with no-tillage increased $82/ha over conventional tillage because of increased yield and lower machinery depreciation costs. (Author's abstract)
W90-03277

RESPONSE OF FIVE FOOD LEGUME CROPS TO AN IRRIGATION GRADIENT IMPOSED DURING REPRODUCTIVE GROWTH.
Chiang Mai Univ. (Thailand). Faculty of Agriculture.
C. Senthong, and R. K. Pandey.
Agronomy Journal AGJOAT, Vol. 81, No. 4, p 680-686, Jul/Aug 1989. 3 fig, 5 tab, 17 ref.

Descriptors: *Plant growth, *Irrigation effects, *Legumes, *Soybeans, *Peanuts, *Sprinkler irrigation, *Soil-water-plant relationships, *Mungbean, *Cowpea, *Pigeonpea, Rice, Tropical regions, Semiarid climates, Silt, Loam, Clays.

Food legumes, an excellent source of protein and soil fertility improvement, offer small farmers a means of intensifying cropping on rice lands in semiarid and tropical regions. Unfortunately food legume productivity is often limited by variation in the amount and distribution of rainfall. This study was conducted to compare differential responses of mungbean (Vigna radiata L.), soybean (Glycine max (L.) Merr.), cowpea (Vigna unguiculata (L.) Walp.), peanut (Arachis hypogaea L.), and pigeon-

pea (Cajunus cajan L.) to a soil water gradient imposed during the reproductive growth phase. Field studies were conducted on Lipa clay loam, an isohyperthemic Typic Hapludoll silt loam soil, using a line source sprinkler irrigation system at the International Rice Research Institute, Philippines, from January to May, 1985 to 1986. Among the five species, peanut yielded significantly higher across the irrigation regimes in both years. Lack of water in the driest regime (50% water deficit replacement) reduced the seed yield of mungbean by an average of 43%, soybean by 39%, cowpea by 34%, and peanut by 32%. However, pigeonpea seed yield increased by an average of 31% in the driest regime. Seed yield increases per mm of total irrigation water plus rainfall were 3.46 and 5.61 kg/ha in soybean, and 3.55 and 5.67 kg/ha in peanut in 1985 and 1986, respectively. However, pigeonpea yield per mm of total irrigation water plus rainfall declined 1.53 kg/ha in 1985 and 1.27 kg/ha in 1986. Peanut performed best in irrigated as well as in rainfed environments, followed by cowpea, soybean, and mungbean. Pigeonpea was suitable only for the relatively dry, rainfed environment. Results indicate the need to match the suitable food legumes to maximize the rice land use. (Author's abstract)
W90-03279

SALINITY EFFECTS ON RYE GRAIN YIELD, QUALITY, VEGETATIVE GROWTH, AND EMERGENCE.
Agricultural Research Service, Riverside, CA. Salinity Lab.
For primary bibliographic entry see Field 3C.
W90-03280

CORN YIELD AND RESIDUAL SOIL NITRATE AS AFFECTED BY TIME AND RATE OF NITROGEN APPLICATION.
Vermont Univ., Burlington. Dept. of Plant and Soil Science.
For primary bibliographic entry see Field 5G.
W90-03282

COTTON CANOPY AND DRYING EFFECTS ON RUNOFF DURING IRRIGATION WITH MOVING SPRINKLER SYSTEMS.
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Inst. of Soil and Water.
M. Ben-Hur, Z. Plaut, I. Shainberg, A. Meiri, and M. Agassi.
Agronomy Journal AGJOAT, Vol. 81, No. 5, p 752-757, Sep/Oct 1989. 4 fig, 2 tab, 21 ref.

Descriptors: *Soil-water-plant relationships, *Drying, *Soil physical properties, *Soil compaction, *Soil absorption capacity, *Cotton, *Irrigation effects, *Sprinkler irrigation, *Agricultural runoff, *Soil moisture retention, Silt, Loam, Clays, Loess, Canopy.

Self-propelled moving sprinkler irrigation systems have become increasingly popular in recent years. However, high amounts of runoff were measured from fields during irrigation with moving sprinkler irrigation systems. Surface runoff from a silt loam loess soil and a clay vertisol soil under different irrigation management was studied in field plots. The experimental fields were irrigated with a lateral moving sprinkler irrigation system (spray nozzle) with a discharge of 650 L/m/h and an average water application rate of about 100 mm/h. The percent surface runoff in loess soils was 22% and 0% in vertisol soil, under straw mulch conditions vs 53% for loess and 39% for vertisol soils under unmulched conditions. The greater runoff was due mainly to crust formation at the soil surface. The impact energy of the irrigation water drops caused the soil surface structure to break down and form a surface crust with a resultant decrease in the infiltration rate. Coverage of the loess-crusted soil surface by the cotton canopy did not reduce the percent runoff from weekly irrigations of 50 mm. A drying period of 7 days between water applications did not break the crust, which was formed at the beginning of the irrigation season, and the large amount of runoff (50%) remained constant until the end of the season. Con-

versely, 14 to 18 days of drying caused a breakage of the crust, resulting in increased infiltration rate. Under these conditions, the cotton canopy prevented the reformation of the crust during consecutive irrigations and the runoff decreased to 15% at the end of the season. When the amount of water per irrigation was 15 to 30 mm and the drying period was 2 to 3 days, the runoff value was about 20%. This low percentage apparently resulted from insufficient amounts of water necessary to form a fully developed crust. (Author's abstract) W90-03283

SPRINKLER IRRIGATION EFFECTS ON DETERMINATE SOYBEAN YIELD AND LODGING ON A CLAY SOIL.
Louisiana Agricultural Experiment Station, St. Joseph. Northeast Research Station.
D. J. Boquet.
Agronomy Journal AGJOAT, Vol. 81, No. 5, p 793-797, Sep/Oct 1989. 3 tab, 21 ref.

Descriptors: *Sprinkler irrigation, *Crop yield, *Clays, *Soybeans, *Soil water, *Irrigation effects, *Crop production, Agricultural hydrology, Drought effects, Water use efficiency.

Drought stress can reduce the yield of soybean grown in the middle and lower Mississippi River Valley. A 3-year field study on Sharkey clay determined the effects of four soil water levels and two row spacings on the growth and yield of cultivars Forrest, Centennial, and Braxton. Irrigation was applied in the four treatments when (i) soil water matrix potential at both the 15 and 30 cm depths reached -70 J/kg, (ii) soil water matrix potential at all depths between 15 and 76 cm reached -70 J/kg, (iii) soil water matrix potential at both the 15 and 30 cm depths reached -70 J/kg, but only after the R1-R2 (Fehr and Caviness soybean growth stage) growth stage (Fehr and Caviness soybean growth stage), and (iv) there was no irrigation. Soybean was planted at interrow spacings of 0.5 and 1.0 m. Irrigation significantly increased yield of each cultivar at each row spacing in each year, but there were no yield of differences among the regimes at either row spacing. Average no irrigation yields were 2.86 Mg/ha in 1982, 3.20 Mg/ha in 1983, and 2.97 Mg/ha in 1984. Yield increase from irrigation was 10% in 1982, 8% in 1983, and 16% in 1984. Irrigated yield of Forrest was 3.47 Mg/ha, Centennial was 3.17 Mg/ha, and Braxton was 3.40 Mg/ha, but water use efficiency was greatest with Forrest. Irrigation prior to R2 increased lodging up to 100%, and up to 50% when irrigated after R2. Severe lodging may have reduced irrigated yields. Relative yield increase from irrigation was limited by adequate rainfall and soil water storage, which resulted in high no irrigation yields. The most efficient water regime was one based on an early maturing cultivar and soil water matrix potential measured at a depth of 76 cm. (Author's abstract) W90-03284

WATER-USE EFFICIENCY AND LIGHT INTERCEPTION OF SEMIDWARF AND STANDARD-HEIGHT SUNFLOWER HYBRIDS GROWN IN DIFFERENT ROW ARRANGEMENTS.
Universidade Federal da Paraiba, Areia (Brazil). Dept. of Crop Science.
E. Zaffaroni, and A. A. Schneiter.
Agronomy Journal AGJOAT, Vol. 81, No. 5, p 831-836, Sep/Oct 1989. 4 fig, 3 tab, 21 ref.

Descriptors: *Soil-water-plant relationships, *Water use efficiency, *Light quality, *Agricultural practices, *Energy use efficiency, *Water use, *Lighting, *Sunflowers, Interception, Soil moisture deficiency, North Dakota, Energy, Semidwarf sunflowers.

Semidwarf sunflower (Helianthus annuus L.) may have potential for adaptation in large areas where conventional-height sunflowers are currently grown. To develop improved production practices for this plant type, a better understanding of light and water use is needed. The objective of this study was to evaluate light interception, water-use efficiency, and energy-use efficiency of semidwarf and standard-height sunflower hybrids grown

under various row spacings. Field studies were conducted at Prosper, ND during the 1984 and 1985 growing seasons. Row arrangements consisted of (i) conventional rows, spaced 0.76 m apart; (ii) solid seeding rows spaced 0.38 m apart; and (iii) twin rows, two rows 0.19 m apart on 0.76-m centers at populations of 35,000, 50,000 and 65,000 plants/ha. Soil-water depletion at different levels of the soil profile was similar for both plant types during 1984, but statistically greater for the standard-height hybrid during 1985. In general, soil-water depletion was greater under solid seeding both years. Total water use and water-use efficiency were not statistically different between hybrids or among row arrangements in combined analysis across years. In 1985, water-use efficiency was statistically higher for the semidwarf hybrid caused by Sclerotinia head rot (Sclerotinia sclerotiorum). Light interception among treatments was not different in 1984, but in 1985 was higher for sunflowers sown at solid seeding and twin rows than in conventional rows. Energy-use efficiency was not different among treatments in 1984, while in 1985, the standard-height hybrid had statistically higher values (1.29%). During this year energy-use efficiency significantly increased from 0.99 to 1.33% as plant population increased. (Author's abstract) W90-03286

RESPONSE OF BANANA TO DRIP IRRIGATION, WATER AMOUNTS AND FERTILIZATION REGIMES.
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
E. Lahav, and D. Kalmar.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 19, No. 1, p 25-46, Jan 1989. 5 fig, 10 tab, 19 ref.

Descriptors: *Drip irrigation, *Fertilization, *Israel, *Bananas, *Water requirements, *Irrigation effects, Fertilizers, Water costs, Water scarcity.

The price of water in Israel, its availability, and the other options for its use, made it necessary to examine the amount of water actually required by banana (Musa cavendishii Lamb.). Water amounts were fixed according to the evaporation factor from a Class A pan. The factor changed throughout the irrigation season. At the peak of the season, the rate of water application corresponded to an evaporation factor of 0.8, 1.0, 1.2, and 1.4. An additional treatment, with a constant factor of evaporation was applied. Two fertilizer regimes were also tested: a fixed dose of fertilizer applied once a week, and a constant concentration of fertilizer injected into the irrigation water throughout the irrigation season. The water applied amounted to 8450-14,470 cubic m/ha/year. The increased water amount led to an increase in sucker height, earlier flowering, more bunches, and a small increase in average bunch weight. Maximum effects were found in suckers irrigated at an evaporation factor of 1.4, but any increase above the evaporation factor of 1.0 (10,370 cubic m/ha) gave no significant advantage. The suckers irrigated at a factor of 0.8 were inferior to all others. The weekly fertilizer application had a slight but nonsignificant advantage over the continuous fertilization regime. (Author's abstract) W90-03294

INFLUENCES OF NITROGEN TREATMENTS AND IRRIGATION METHODS ON SOIL CHEMICAL PROPERTIES.
Arkansas Univ. at Monticello. Southeast Research and Extension Center.
J. S. McConnell, M. H. Wilkerson, and G. A. Mitchell.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 19, No. 16, p 1925-1943, Dec 1988. 8 tab, 26 ref.

Descriptors: *Irrigation effects, *Soil chemistry, *Soil analysis, *Fertilization, *Irrigation efficiency, *Furrow irrigation, *Nitrogen, Hydrogen ion concentration, Conductivity, Phosphorus, Potassium, Organic matter, Nitrates.

Changes in soil chemical properties were investigated in conjunction with an ongoing study of

fertility and irrigation relationships of cotton. Four irrigation methods and five nitrogen fertilization rates were the primary focus of the study. The four irrigation regimes studied were: high frequency center pivot, low frequency center pivot, furrow irrigated, and unirrigated. Nitrogen rates were 0, 30, 60, 90, and 120 lb N/A. Soil samples were collected from each plot in 6-inch increments to a depth of 24 inches in 1982 and again in 1986 after four years of continuous cotton production. The soil samples were analyzed for pH, organic matter, P, K, electrical conductivity, and NO3(-)-N. All background soil characteristics were found to vary with depth with the exception of NO3(-)-N. The follow-up sampling and testing in 1986 showed significant differences in soil properties as a function of irrigation, N-fertilization, depth, and their interactions. Nitrates were accumulated in the 18 to 24-inch depth under high (120 lb N/A) fertilization, and in the 0 to 6-inch depth under the four lower treatments. Soil pH was highest in the furrow and high frequency center pivot irrigated regimes and lowest in the unirrigated regime. Soil pH also decreased with depth. Electrical conductivity of the soil was highest in the high frequency regime and not significantly different among the other three irrigation methods. The organic matter content of the soil was greatest in the high frequency regime but not significantly different in the low frequency, furrow, or unirrigated blocks. Soil organic matter was found to decrease with depth through 18 inches in all cases. The P and K status of the soil was not changed as a result of the N fertilization or irrigation treatments. (Author's abstract) W90-03300

SALINE IRRIGATION REGIME FOR IMPROVING TOMATO FRUIT QUALITY WITHOUT REDUCING YIELD.
Ben-Gurion Univ. of the Negev, Beersheba (Israel). Boyko Inst. for Agriculture and Applied Biology.
For primary bibliographic entry see Field 3C.
W90-03317

TOMATO RESPONSE TO TRICKLE IRRIGATION AND BLACK POLYETHYLENE MULCH.
Agricultural Research Service, Charleston, S.C. Vegetable Lab.
H. S. Bhella.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 113, No. 4, p 543-546, Jul 1988. 2 fig, 4 tab, 23 ref.

Descriptors: *Irrigation effects, *Tomatoes, *Indiana, *Trickle irrigation, *Plant growth, *Mulches, Zinc, Phosphorus, Boron, Nitrates, Ammonium, Magnesium, Soil analysis, Irrigation efficiency, Polyethylene mulch, Plastics.

A 2-year field study was conducted on a fine sandy loam soil near Vincennes, Ind., to evaluate tomato (Lycopersicon esculentum Mill. cv. Sunny) response to trickle irrigation and black polyethylene mulch. Use of trickle irrigation resulted in higher petiole P and B and lower Zn concentrations than using no irrigation. Trickle-irrigated soils had lower soil NH4-N, NO3-N, and K and higher Mg concentrations than non-irrigated soils. Soil NH4-N, NO3-N and Mg concentrations were higher in soils mulched with polyethylene than in soils without mulch. The use of trickle irrigation increased plant height, whereas polyethylene mulch increased plant spread and dry matter production. Early, late, and total yields were improved with all trickle irrigation and polyethylene mulch treatments. Total yields were 66% greater for plants grown with polyethylene mulch, 70% greater for trickle irrigation, and 123% greater for plants grown with polyethylene mulch plus trickle irrigation than controls. (Author's abstract) W90-03318

WATER RELATIONS OF GRAPEFRUIT TREES IN RESPONSE TO DRIP, MICROSPRINKLER, AND OVERHEAD SPRINKLER IRRIGATION.
Citrus Research and Education Center, Lake

Group 3F—Conservation In Agriculture

Alfred, FL.
M. Zekri, and L. R. Parsons.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 113, No. 6, p 819-823, Nov 1988. 4 fig, 1 tab, 24 ref.

Descriptors: *Soil-water-plant relationships, *Sprinkler irrigation, *Drip irrigation, *Irrigation efficiency, *Citrus fruits, *Grapefruit trees, *Florida, Leaves, Water potential, Stomatal conductance, Water stress.

Water relations responses of 21-year-old grapefruit trees (Citrus paradisi Macf.) irrigated by three types of irrigation systems were compared. Drip, undertree microsprinkler, and overhead sprinkler with application levels of 150 and 450 mm of water per year were compared. Leaf water potential, stomatal conductance, and soil water status were measured under field conditions on a deep, well-drained sandy soil in central Florida. In the early part of a dry spring period, there were no differences in midday or early morning leaf water potential, but, by the end of this period, significant differences in leaf water potential were found among all three irrigation treatments. Highest leaf water potential and stomatal conductance values were maintained in the overhead sprinkler blocks. No midday stomatal closure was observed under the conditions of this study. Relationships among diurnal leaf water potentials, vapor pressure deficits, and stomatal conductance showed hysteresis; this affected the correlations among these factors. Greater water stress occurred in trees irrigated with drip than in trees irrigated with overhead sprinkler systems, but responses to microsprinklers were generally intermediate between the overhead sprinkler and the drip treatments. In an area with high rainfall and sandy soils, increased irrigation coverage can reduce leaf water stress. (Author's abstract)
W90-03319

CALCIUM AMENDMENTS FOR WATER PENETRATION IN FLOODING SYSTEMS.
California Univ., Davis. Dept. of Land, Air and Water Resources.
W. E. Wildman, W. H. Krueger, and R. E. Pelton.
California Agriculture CAGRA3, Vol. 43, No. 3, p 14, May-June 1989. 2 fig, 2 tab.

Descriptors: *Soil management, *Irrigation, *Irrigation efficiency, *Gypsum, Nitrates, Calcium compounds, Soil treatment.

Gypsum is commonly used as an amendment in reclaiming sodic soils. It also is used to improve water penetration in nonsodic soils, either by lowering the sodium adsorption ratio (SAR) of well water used for irrigation or by increasing the soluble salt content of naturally pure irrigation water. The effectiveness and duration of surface-spread gypsum with that of dissolved gypsum in a Glenn County almond orchard was compared. In both cases, about 1 ton per acre of gypsum was applied. A third treatment used dissolved calcium nitrate, also applied to the irrigation water to add about 3 milliequivalents per liter. Dissolved gypsum and calcium nitrate each increased infiltration rates over the control for each of the 15 irrigations to which they were added. An equivalent amount of gypsum spread on the surface at the beginning of the experiment had the same beneficial effect for only 10 irrigations. In the surface-spread treatment, runoff from the first irrigation was saturated with gypsum, but amounts dropped by almost half at each of the next four irrigations. The level was below that of the dissolved calcium treatments by the fifth irrigation and near the average control level by the eighth irrigation. Meanwhile, the dissolved gypsum, calcium nitrate, and control averaged about 3.9, 4.1, and 1.3 milliequivalents per liter, respectively, over the 15 irrigations. In the surface-spread treatment, infiltration was significantly higher in the first six irrigations, remained equal to that in the dissolved calcium treatments for the seventh to tenth irrigations, then dropped to near that of the controls. The depth of water penetration measured with a steel probe paralleled the infiltration results and emphasized the severe water penetration problem in this orchard. Regardless of treatment, water penetration was deepest

near a berm, intermediate in the center between rows, and shallowest in wheel tracks. (Ence-PTT)
W90-03322

ORCHARD SOIL MANAGEMENT SYSTEMS INFLUENCE RAINFALL INFILTRATION.
Appalachian Fruit Research Station, Kearneysville, WV.
D. M. Glenn, and W. V. Welker.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 114, No. 1, p 10-14, Jan 1989. 2 fig, 2 tab, 22 ref.

Descriptors: *Cultivated lands, *Orchards, *Rainfall infiltration, *Soil management, Peach trees, Herbicides, Sod, Herbicide strip, Mowed sod, Killed sod.

A study was conducted to assess the effect of four soil management systems: herbicide strip, cultivated strip, mowed sod, and killed sod strip on rainfall infiltration in two young peach (Prunus persica (L.) Batsch) orchards. Soil water content (0 m to 0.90 m depth) was measured immediately before a rainfall event and then as soon as possible after the rain. During the first growing season, mowed sod captured more rainfall than killed sod strip, herbicide strip, or cultivated strip in the spring and summer months. In the fall, when soil water levels were reduced, all of the soil management systems were equally effective in reducing rainfall runoff. During the second and third growing seasons, the killed sod strip system often captured as much rainfall as mowed strip and more than herbicide strip and cultivated strip, when killed sod residue covered 50% or more of the surface. When less than 10% soil cover remained in the killed sod strip treatment, it was no more effective in reducing runoff than the herbicide strip or cultivated strip treatments. Growth and yield parameters were lowest in the mowed strip due to sod interference. Killed sod strip generally provided greater growth and yield than the cultivated and herbicide strips. (Author's abstract)
W90-03360

COMPARISON OF SUBSURFACE TRICKLE AND FURROW IRRIGATION ON PLASTIC-MULCHED AND BARE SOIL FOR TOMATO PRODUCTION.
Texas A and M Univ., Weslaco. Agricultural Research and Extension Center.
C. R. Bogle, T. K. Hartz, and C. Nunez.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 114, No. 1, p 40-43, Jan 1989. 1 fig, 3 tab, 26 ref.

Descriptors: *Water conservation, *Subsurface irrigation, *Trickle irrigation, *Furrow irrigation, *Irrigation efficiency, *Tomatoes, *Mulches, Plant growth, Plastic mulch, Fruit yield, Market value.

Subsurface trickle and furrow irrigation of fresh-market tomato (Lycopersicon esculentum Mill.), with or without plastic mulch, were compared for three consecutive growing seasons. Plots were irrigated when available soil water was 40% depleted. Marketable tomato yield was 22% greater for plants grown with trickle irrigation than with furrow irrigation. Use of black plastic mulch resulted in 31% greater marketable tomato yield in Spring 1983 and 16% greater yield in Spring 1984, than similar bare-soil (unmulched) treatments. In Fall 1983, use of white/black (top/bottom) laminated plastic mulch reduced yields by 12% compared to similar unmulched treatments. Total water (irrigation plus precipitation) applied to furrow-irrigated plots nearly equalled pan evaporation. Trickle-irrigated plots received less than 45% of pan evaporation in all seasons, resulting in increased water-use efficiency with drip irrigation. Trickle irrigation as applied did not affect soluble salts concentration in the soils. (Author's abstract)
W90-03361

EFFECTS OF IRRIGATION REGIMES ON YIELD AND WATER USE OF SUMMER SQUASH.
Georgia Coastal Plain Experiment Station, Tifton.
J. R. Stansell, and D. A. Smittle.

Journal of the American Society for Horticultural Science JOSHB5, Vol. 114, No. 2, p 196-199, Mar 1989. 3 tab, 14 ref.

Descriptors: *Moisture tension, *Irrigation efficiency, *Squashes, *Evapotranspiration, Summer squash, Lysimeters, Fruit yield, Soil water.

Summer squash (Cucurbita pepo L. cv. Dixie hybrid) were grown in drainage lysimeters under closely controlled and monitored soil water regimes. Variables included three irrigation treatments, three growing seasons, and two soil types. Marketable fruit yield was greatest and production cost per kilogram of marketable fruit was least when squash was irrigated at 25 kPa of soil water tension. Yields were greatest for the spring season of production and least for the fall season. Regression equations are provided to describe the relationships of water use to plantage and to compute daily evapotranspiration:pan evaporation ratios (crop factors) for squash irrigated at 25, 50, and 75 kPa of soil water tension during the spring, summer, or fall production. (Author's abstract)
W90-03362

WATER QUANTITY AND TIME OF N AND K APPLICATION FOR TRICKLE-IRRIGATED TOMATOES.
Florida Univ., Gainesville. Dept. of Vegetable Crops.
S. J. Locascio, S. M. Olson, and F. M. Rhoads.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 114, No. 2, p 265-268, Mar 1989. 5 tab, 13 ref.

Descriptors: *Tomatoes, *Irrigation efficiency, *Fertilization, Mulches, Trickle irrigation, Nitrogen, Potassium, Market value, Pan evaporation, Irrigation practices.

Tomatoes (Lycopersicon esculentum Mill.) were grown during two seasons at two locations on fine sands and fine sandy loam soils to study the influence of water quantity, frequency of water application, and timing of N and K application for polyethylene-mulched, trickle-irrigated fresh-market tomatoes. Water quantities were 0.50 and 1.0 times pan evaporation applied one or three times daily. Nitrogen and K were applied 100% preplant or 40% applied preplant and 60% applied with trickle irrigation. Higher tomato leaf tissue N and K concentrations in one of the two seasons and higher fruit yields were obtained with 0.5 than with 1.0 time pan water evaporation on a fine sand at Gainesville, FL. On a fine sandy loam soil at Quincy, fruit yields were higher in a relatively dry season with the higher water quantity and not influenced by the water quantity applied in the second relatively wet season. The number of daily water applications (1 vs. 3) at both locations had no effect on N and K uptake or fruit yields. (Mertz-PTT)
W90-03363

NUTRITION AND YIELD OF YOUNG APPLE TREES IRRIGATED WITH MUNICIPAL WASTE WATER.
Agriculture Canada, Summerland (British Columbia). Research Station.
G. H. Neilsen, D. S. Stevenson, J. J. Fitzpatrick, and C. H. Brownlee.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 114, No. 3, p 377-383, May 1989. 5 tab, 27 ref.

Descriptors: *Municipal wastewater, *Impaired water use, *Wastewater irrigation, *Apples, *Irrigation efficiency, *Fertilization, *Plant growth, *Fruit crops, Nitrogen, Phosphorus, Potassium, Well water.

'Macspur McIntosh' and 'Red Chief Delicious' apple (Malus domestica Borkh.) on M.7a rootstock were subjected to treatments involving all combinations of two types of irrigation water (well-water or municipal effluent) from 1983, the year of planting through 1987 and three rates of N fertilization (0, 200, 400 g NH4NO3/tree/year), from 1984 to 1987. The zero N treatment was increased

to 100 g NH4NO3/tree/year in 1986 due to low vigor of these trees. Effluent irrigation increased leaf N, P, and K concentration in 4 or 5 years for 'McIntosh' and 2 years for 'Delicious', while leaf P and K were decreased at the highest N rate in 2 years for each cultivar. No major horticultural limitation were observed in the successful establishment and the first 5 yrs of growth of McIntosh and Delicious apples when irrigated with effluent wastewater. (Mertz-PTT)
W90-03364

GROWTH OF CHRYSANTHEMUM USING AN IRRIGATION SYSTEM CONTROLLED BY SOIL MOISTURE TENSION.
California Univ., Davis. Dept. of Environmental Horticulture.
J. H. Lieth, and D. W. Burger.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 114, No. 3, p 387-392, May 1989. 5 fig, 2 tab, 11 ref.

Descriptors: *Irrigation efficiency, *Soil water, *Chrysanthemums, *Plant growth, *Moisture tension.

Chrysanthemum plants were grown in containers using an irrigation system based either on time (5 min/day) or on soil moisture tensions of -1.5, -3.5, -7.5, and -15 kPa. Soil moisture tensions of -7.5 or -15 kPa caused significant reductions over the time-based treatment in fresh and dry weights of leaves, stems, and inflorescences and total leaf area, but had no influence on inflorescence diameter or cropping time. Stem length was reduced in those plants exposed to the two higher tensions; however, the resulting cut flowers were still long enough to satisfy commercial demands. The amount of water applied in tension-based treatments was 8% to 24% that applied in the time-based treatment. The -1.5 and -3.5 kPa treatments were best suited for minimizing water use while maintaining high crop productivity. (Author's abstract)
W90-03365

SEASONAL SOIL WATERLOGGING INFLUENCES WATER RELATIONS AND LEAF NUTRIENT CONTENT OF BEARING APPLE TREES.
Maine Univ. at Orono. Dept. of Plant and Soil Sciences.
W. C. Olien.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 114, No. 4, p 537-542, Jul 1989. 3 fig, 3 tab, 22 ref.

Descriptors: *Soil-water-plant relationships, *Waterlogging, *Apples, *Fruit crops, *Soil water, *Transpiration, Seasonal variation, Conductance, Stomatal conductance, Plant growth, Water potential.

Bearing 'Macspur'/M.26 apple trees (Malus domestica Borkh.) were grown in plastic-lined basins under orchard conditions. Four treatments were imposed in each of 3 years consisting of controls and 6-week periods of soil waterlogging in the spring, summer, or fall. Stomatal conductance, transpiration rate, leaf water content, and stem water potential were measured at the end of each waterlogging period. Stomatal conductance was significantly reduced by spring and summer waterlogging, but not by fall waterlogging. Reduction in stomatal conductance and transpiration rate generally increased over years. Stem water potential after spring and fall water logging averaged 8% less negative than controls in all 3 years, with no trend over the 3 years. In contrast, stem water potential of summer-waterlogged trees was unaffected in the first year, 45% was more negative in the second year, and 31% less negative than controls in the third year of treatment. Annual reductions in growth and yield due to the waterlogging treatments were related to decreased stomatal conductance and to both negative and positive changes in stem water potential. Leaf levels of N, P, K, and Cu measured in July were reduced only by summer waterlogging, with no trend in response over years. (Author's abstract)
W90-03366

POSSIBLE USE OF THE CROP WATER STRESS INDEX AS AN INDICATOR OF EVAPOTRANSPIRATION DEFICITS AND YIELD REDUCTIONS IN SWEET CORN.
Oregon State Univ., Corvallis. Dept. of Horticulture.
W. S. Braunworth, and H. J. Mack.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 114, No. 4, p 542-546, Jul 1989. 7 fig, 1 tab, 23 ref.

Descriptors: *Soil-water-plant relationships, *Evapotranspiration, *Irrigation efficiency, *Corn, *Water stress, Crop water stress index, Crop yield.

The crop water stress index may be useful for optimal irrigation timing. This preliminary study evaluates the relationships between the crop water stress index and evapotranspiration and yield. The crop water stress index was also characterized on an hourly basis. Once-daily crop water stress index measurements after full ground cover was established and hourly crop water stress index measurements on 4 days were made in sweet corn irrigation experiments in 1984 and 1985. The gradient of water applied included five irrigation levels established from 0% to 100%, with the 100% level intended to refill the root zone to field capacity, after 50% depletion of available water, at each irrigation. Crop water stress index values, obtained hourly throughout the day, were highest between 1000 and 1700 hr. Crop water stress index values tended to be higher in the less-irrigated plots (40% and less) than in those that received greater amounts of water (57% to 100% treatment levels). Seasonal average crop water stress index values (midday measurements) were closely related to the seasonal evapotranspiration deficit (correspondence ranged from 0.45 to 0.96), but there was not the expected 1:1 relationship of crop water stress index and evapotranspiration deficit. The yield deficit of good, husked ears was also closely related to crop water stress index (correspondence ranged from 0.82 to 0.93), but differences in these relationships between years and experiments indicate that crop water stress index measurements must be improved. (Author's abstract)
W90-03367

COMPARISON OF THE AVAILABLE-WATER CAPACITIES OF PATUMAHOE CLAY LOAM UNDER PASTURE AND CULTIVATION.
New Zealand Soil Bureau, Lower Hutt.
For primary bibliographic entry see Field 2G.
W90-03374

CORN LEAF WATER POTENTIAL AND WATER USE EFFICIENCY UNDER THREE CONSERVATION TILLAGE SYSTEMS.
Wisconsin Univ.-Madison. Dept. of Soil Science.
A. M. Al-Darby, B. Lowery, and T. C. Daniel.
Soil and Tillage Research SOTRD5, Vol. 9, No. 3, p 241-254, May 1987. 5 fig, 5 tab, 27 ref.

Descriptors: *Soil-water-plant relationships, *Corn, *Soil water potential, *Cultivation, *Soil water, Conservation tillage, Silt, Loam, Sand, Leaves, Water potential, Crop yield.

Corn was grown using three conservation tillage systems: till-plant, chisel and no-till, and conventional moldboard plow on two soils (silt loam and loamy sand). These tillage systems were compared for soil water storage capabilities, leaf water potential, dry matter and grain yield production per unit of water depleted. Soil water storage ranked no-till greater than chisel greater than till-plant greater than conventional moldboard plow through the growing season in all profile segments for both soils with the exception of the 0.25 to 1 m zone in 1984 for the silt loam soil, where soil water storage ranked no-till greater than conventional plow greater than till-plant greater than chisel. Greater water storage differences between the conservation tillage systems and conventional moldboard plow were found for deeper depths (> 0.75 m) in the loamy sand soil. Leaf water potential for both sites ranked no-till greater than chisel greater than till-plant greater than conventional plow, indicating higher water stress for corn grown with conventional moldboard plow compared with no-till.

In a relatively dry year such as 1983, the dry matter per unit of water depleted was 72.3 kg/ha/mm for chisel, 64.3 kg/ha/mm for no-till, 60.1 kg/ha/mm for till-plant and 59.6 kg/ha/mm for conventional moldboard plow, for the silt loam site. Although no significant differences were detected the dry matter production per unit of water depleted from no-till was higher than chisel by 1.1%, till-plant by 10.2% and conventional plow by 12.4% in 1983 for the loamy sand site. Grain yield per unit of water depleted was not significantly different in all years and soil types with the exception of 1983 on the loamy sand soil where no-till was higher than conventional moldboard plow by 20.8%, chisel by 12.9%, and till-plant by 14.6%. The greater amounts of water stored with the conservation tillage systems eliminated the potential for reduction in dry matter and grain yield with these systems due to lower soil temperature early in the growing season. (Author's abstract)
W90-03376

RUNOFF, SEDIMENT AND NUTRIENT LOSSES FROM VARIOUS TILLAGE SYSTEMS OF COTTON.
Auburn Univ., AL. Dept. of Agricultural Engineering.
K. H. Yoo, J. T. Touchton, and R. H. Walker.
Soil and Tillage Research SOTRD5, Vol. 12, No. 1, p 13-24, Jul 1988. 2 fig, 4 tab, 17 ref.

Descriptors: *Nonpoint pollution sources, *Tillage, *Erosion control, *Agricultural runoff, *Cultivation, *Cotton, *Wheat, Sedimentation, Cover crops, Tillage systems, Weed control, Nitrates, Phosphorus, Water quality.

Runoff, sediment and nutrient losses were studied from three tillage systems of cotton: (1) no-till without a cover crop; (2) reduced-till with a winter wheat as a cover crop; (3) conventional-till in the Tennessee Valley of north Alabama during the 1985 growing season. Runoff samples were collected from natural rainfall events and analyzed for sediment and nutrient losses. Among the three tillage systems the reduced-till with wheat cover system was the most effective in reducing the surface runoff, sediment and nutrient losses while maintaining comparable crop yield. Runoff and sediment concentrations from the conventional-till system were high during the critical period (from planting to the last cultivation of the conventional-till system). During the non-critical period (between the last cultivation of the conventional-till system to harvesting) sediment concentrations from all tillage systems were relatively low even with high-runoff events. Summer cultivations reduced both surface runoff and sediment concentrations from the conventional-till system. This may signify that a combination of conservation tillage and summer cultivation has the potential for controlling weeds without enhancing soil erosion. Concentration of ammonium nitrogen and soluble-phosphorus concentration in surface runoff were higher than the recommended standard level for public water supplies and the growth of algae, respectively. Concentration of nitrate nitrogen in the the surface runoff was well within the upper limit for drinking water. (Author's abstract)
W90-03377

LAND PREPARATION REQUIREMENTS FOR RAINFED RICE AS AFFECTED BY CLIMATIC WATER BALANCE AND TILLAGE PROPERTIES OF LOWLAND SOILS.
International Rice Research Inst., Los Banos, Laguna (Philippines).
B. Mambani, S. K. De Datta, and C. A. Redulla.
Soil and Tillage Research SOTRD5, Vol. 14, No. 3, p 219-230, Aug 1989. 4 fig, 4 tab, 13 ref.

Descriptors: *Soil-water-plant relationships, *Hydrologic budget, *Cultivation, *Rice, *Soil water, Tillage, Conventional plowing, Clays, Loam, Sand, Clay loam, Evaporation, Soil properties.

Tillage effects on four lowland soils were evaluated and the relationship between climatic water balance (W=difference between cumulative rainfall and evaporation) and rice response to land

preparation was determined under rainfed conditions. Tillage treatments included zero tillage, rototilling, conventional plowing, shallow puddling and thorough puddling. The soils were Maahas clay (Andaqueptic Haplaquoll), San Miguel sandy loam (Aeric Tropaquept), Maligaya clay loam (Vertic Tropaquept) and Maligaya clay (Vertic Tropaquept). Conventional plowing increased hydraulic conductivity in all four soils. Wet tillage had the contrary effect, which was more apparent in sandy loam and clay loam soils than in clay soils. Soil penetration resistance decreased with increase in tillage intensity under favorable climatic water balance (W greater than 100 cm). Under inadequate moisture conditions (water balance less than 100 cm), however, conventional plowing was more favorable for soil tilth than was wet tillage. The rice suffered a significant yield loss at hydraulic conductivity greater than 1.31 cm/day when the root length density was less than 1.24 cm/cubic cm. Root activity was severely reduced at moisture stress greater than 0.005 MPa and soil penetration resistance greater than 0.57 MPa. Decreasing hydraulic conductivity improved the profile moisture retention in sandy loam soil, but had no effect on moisture regime in clay soils with a shallow water table (0-30 cm deep) or in clay loam under high climatic water balance (W greater than 100 cm). As a result, tillage had no effect on grain yield in clay soils with a shallow water table or in clay loam soil under high climatic water balance. In sandy loam, however, thorough puddling significantly increased grain production. It was concluded that tillage is not required to alleviate soil physical limitations in rainfed lowland rice production in low permeable soils under an adequate climatic water balance. Wet tillage is a prerequisite for rice productivity in medium to course-textured soils in drought-prone environments, although thorough puddling showed no advantage over shallow puddling. (Author's abstract)
W90-03380

WATER MOVEMENT AND MACROPOROSITY OF AN AUSTRALIAN ALFISOL UNDER DIFFERENT TILLAGE AND PASTURE CONDITIONS.
New South Wales Dept. of Agriculture, Rydalmere (Australia). Biological and Chemical Research Inst.
For primary bibliographic entry see Field 2G.
W90-03382

DEPLETION AND MOVEMENT OF WATER BENEATH CEREAL CROPS GROWN ON A SHALLOW SOIL OVERLYING CHALK.
Reading Univ. (England). Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W90-03407

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

COMPARISON OF STATE CONSTRUCTION SETBACKS TO MANAGE DEVELOPMENT IN COASTAL HAZARD AREAS.
National Oceanic and Atmospheric Administration, Washington, DC. Office of Ocean and Coastal Resource Management.
J. M. Houlahan.
Coastal Management CZMJBF, Vol. 17, No. 3, p 219-228, 1989. 3 tab, 34 ref.

Descriptors: *Coastal zone management, *Coastal engineering, *Erosion control, *Regional development, Construction methods, *Water level, Hazards, Legal aspects, Management planning, Alternative planning, Recession, Structure, Great Lakes.

Significant coastal erosion affects roughly one-quarter of the U.S. coastline, making it one of the biggest problems facing many coastal communities. Congress amended the National Flood Insurance

Act, making federal funds available for proper demolition or relocation of structures that are subject to imminent collapse due to coastal erosion. This amendment, record high Great Lakes water levels, and an ongoing National Academy of Sciences study of alternative erosion control management strategies have focused attention on construction setbacks as a method of managing coastal development. There are different types of state setback programs to protect property and lives from coastal erosion hazards. Eleven states currently use construction setbacks. Annual long-term average recession rates are the basis for the majority of state setbacks. Existing state setback programs and their strengths and weaknesses are compared. Three desirable features of existing programs are examined: (1) designate 'low' and 'high' hazard areas, (2) consider structure size in determining the setback distance, and (3) make the setback program understandable to the public. (Fish-PTT)
W90-02551

OVERALL VIEW OF THE PROBLEMS CONCERNING THE HYDRAULIC ALERT CAUSED BY THE NATURAL DAM AND THE LAKE FORMED AFTER THE LANDSLIDE OF VAL POLA (UNE VUE D'ENSEMBLE DES PROBLEMES CONCERNANT L'ALERT HYDRAULIC CAUSEE PAR LE BARRAGE NATUREL ET PAR LE LAC QUI S'EST FORME PAR SUITE DE L'EBOULEMENT DE VAL POLA).
Ente Nazionale per l'Energia Elettrica, Milan (Italy). Centro di Ricerca Elettrica.
P. Bertacchi, M. Fanelli, and U. Maione.
Houille Blanche HOBLAB, No. 5, p 377-386, 1989. 9 fig, 8 ref. English summary.

Descriptors: *Hydraulic engineering, *Landslides, *Natural levees, *Lakes, Channeling, Overflow, Percolating water, Dams, France.

Physical and mathematical means were used to counter the hydraulic problems that were caused by a catastrophic landslide in Italy that created a natural dam and lake. The landslide on July 28, 1989 created a natural dam 120 m high and 2500 m long. Two villages were destroyed, many houses were flooded, and 27 people were killed. The lake formed by the dam had, within a month, a water capacity of 20 million cu m. Erosion of this natural dam and water running over the dam caused an overflow which could potentially endanger the lives of 26,000 people. Within one month of the landslide, engineers had developed mathematical and physical models leading to the conclusion that a canal should be dug to permit flow of water from the newly formed lake to a river. This would permit the return home of the 26,000 people who had been evacuated. (Author's abstract)
W90-02554

CALCULATION OF THE CAPACITY OF UNLINED CANALS AND CHANNELS.
For primary bibliographic entry see Field 8A.
W90-02558

FLOOD CONTROL EXPERIENCE IN THE USA.
For primary bibliographic entry see Field 6F.
W90-02564

WATER YIELD FROM FOREST SNOWPACK MANAGEMENT: RESEARCH FINDINGS IN ARIZONA AND NEW MEXICO.
Arizona Univ., Tucson. School of Renewable Natural Resources.
P. F. Ffolliott, G. J. Gottfried, and M. B. Baker.
Water Resources Research WRERAQ, Vol. 25, No. 9, p 1999-2007, September 1989. 5 fig, 50 ref.

Descriptors: *Snowmelt, *Snow management, *Computer models, *Forest management, *Water yield, *Runoff forecasting, Snowpack, Snow surveys, Elevation, Arid lands, Forest watersheds, Forest hydrology, Arizona, New Mexico.

Snow falling in high-elevation forests is an important source of water for much of the arid South-

west. Snowpack conditions in Arizona and New Mexico differ from those in more northern regions, because of the variability in annual accumulations and the intermittent melting throughout the winter season. Snow management research in Arizona and New Mexico over the past 25 years has indicated the possibilities of increasing snowmelt water yields through forest management activities. The effects of management can be predicted from forest inventory data. Other research has resulted in the development of snow-runoff forecasting procedures and computer simulation models of forest snowpack dynamics, as well as increasing the general knowledge of snow hydrology. (Author's abstract)
W90-02588

PRESERVATION AND RESTORATION OF THE WATER RESOURCES OF THE ARAL SEA--AN URGENT NATIONAL ECONOMIC PROBLEM.
For primary bibliographic entry see Field 5G.
W90-02692

STORING SEDIMENT AND FREEING FISH.
Army Engineer District, Portland, OR.
For primary bibliographic entry see Field 5G.
W90-02734

SOLVING A STREAMBANK STABILIZATION PROBLEM.
Metropolitan St. Louis Sewer District, MO.
G. Moore.
Public Works PUWOAH, Vol. 120, No. 10, p 139-141, September 1989, 2 fig.

Descriptors: *Urban runoff, *Storm runoff, *Bank stabilization, *Slope protection, Watershed management, Cellular confinement systems, Construction costs.

Watershed development can increase stormwater runoff, which, without proper planning, can enlarge the horizontal and vertical size of drainage paths and jeopardize public and private property. Some methods used by the Metropolitan St. Louis Sewer District to protect property are: gabions, grout-filled geotextile, bags, cellular confinement systems, synthetic grids for walls, sheet pile with rip-rap blanket, grouted rock blanket, erosion control blankets, hand-placed or dumped rip-rap, and conveyance structures (pipe sewers and concrete channels). The North Waterford erosion project is an example of the planning and execution needed for a streambank stabilization project. The solution was to have the District's maintenance department stabilize a 27-in. outlet drainage pipe and provide 90 lineal feet of grouted rock blanket at an estimated cost of $35,000. During the final design phase it was decided to use a cellular confinement system instead of the grouted rock blanket. The cellular confinement system is an expandable, honeycomb structure made of high-density polyethylene. It is designed to confine cohesionless or unstable soils, sand or gravel either in a horizontal position or on inclines up to 45 degrees. Actual construction time of the North Waterford Project was five days, only a third the time projected by design estimates. At a cost of $8.60 per sq ft installed, the confinement system represented a cost savings of $3.55 per sq ft over the grouted-rock alternative, or an overall saving of $10,000 for the project. (Cutty-PTT)
W90-02737

URBAN STORM RUNOFF EFFECTS ON EXCHANGEABLE CATIONS AND PERCOLATING WATER CONSTITUENTS BELOW RECHARGE BASINS.
Agricultural Research Service, Fresno, CA. Water Management Research Lab.
For primary bibliographic entry see Field 5B.
W90-02738

PHYSICALLY BASED HYDROLOGICAL MODELS FOR FLOOD COMPUTATIONS.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).

For primary bibliographic entry see Field 2E.
W90-02967

RELIABILITY CONSTRAINED MARKOV DE-CISION PROGRAMMING AND ITS PRACTI-CAL APPLICATION TO THE OPTIMIZATION OF MULTIPURPOSE RESERVOIR REGULA-TION.
Tsinghua Univ., Beijing (China). Dept. of Hydraulic Engineering.
Q. Liango.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 417-422.

Descriptors: *Model studies, *China, *Multipurpose reservoirs, *Reservoir operation, *Computer models, Computer programs, Algorithms, Markov Decision Programming, Stochastic models, Cost analysis, Danjkangkou Reservoir, Hydroelectric power, Navigation, Irrigation, Reliability, Decision making, Developing countries.

Optimization of regulating a reservoir with multiple objectives is considered. The system is modeled as a periodic Markov Decision Programming (MDP). A procedure is proposed in which the Dynamic Programming (DP) is combined with the use of probability computation in conjunction with penalty costs to derive long-term operating policies to maximize one of the objectives without violating the constraints on the others. The application of this procedure to a reservoir (Danjiangkou Reservoir, Hubein Province, China) with four objectives (power generation, power generation reliability, navigation reliability, and irrigation reliability) demonstrates its power. The model involved 36 decision periods, 64 storage and 10 inflow states, and used the historical inflow records as data to evaluate the derived policy of simulation. The results show that the average yearly amount of electric generation, compared with that from conventional rules, can be increased by at least 4.1% without reducing the requirements of the other objectives. The constrained optimization algorithm used here, which finds an optimal operating policy for maximal power production subject to set quota limits for other objectives, is suitable for the recent conditions in China. (See also W90-03036) (Rochester-PTT)
W90-03097

OPTIMAL MULTIOBJECTIVE OPERATION-AL PLANNING OF A WATER RESOURCES SYSTEM.
Universidade Estadual de Campinas (Brazil). Dept. de Engenharia de Sistemas.
S. Soares, and M. G. Andrade Filho.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 423-430, 6 fig, 10 ref.

Descriptors: *Brazil, *Model studies, *Water resources development, *Reservoirs, *Resources management, *Hydrologic models, Stochastic models, Optimization, Hydroelectric power, Irrigation, Energy composite reservoir model, Sao Francisco River, Management planning, Mathematical models, Performance evaluation.

The optimal multiobjective operational problem of water resources system is considered, with two conflicting objectives: (1) generation of electrical energy and (2) the use of water for irrigation. The effect of the use of water for irrigation on the reliability of system load supply is analyzed. The hydroelectric system is represented by an energy composite reservoir model and the randomness of inflows is considered. The optimal solution is obtained by Stochastic Dynamic Programming. The model is applied to the hydroelectric system of the Sao Francisco River, Northeast Region, Brazil. The curves of risk of load shedding versus irrigation and average load shedding versus irrigation are presented. The system was represented by a composite reservoir of energy. The two-objective problem was approached by the weighting method. The results show that, although the risk of

load shedding increases greatly with the increase in the use of water for irrigation, the expected value of load shedding does not suffer as much. For example, with a weighting factor (a unit transformation factor in terms of irrigation benefit units/hydroelectric benefit units) equal to 5, there would be an average irrigation corresponding to 450 MW of energy, implying a high risk of load shedding (24%), but a low expected value for load shedding (30 MW, or approximately 1.2% of average load demand). The proposed approach can be applied to any reservoir system where the composite model is adequate. (See also W90-03036) (Rochester-PTT)
W90-03098

FLEXIBLE POLYHEDRON METHOD WITH MONOTONICITY ANALYSIS.
Zhejiang Univ., Hangzhou (China). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W90-03099

AQUATIC WEED CONTROL.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
W. T. Haller.
Grounds Maintenance, Vol. 23, No. 4, p 10-16, 90-92, April 1988.

Descriptors: *Aquatic weed control, *Ponds, *Aquatic plants, Herbicides, Biocontrol, Planning, Construction, Maintenance, Drawdown, Management planning, Administrative agencies, Permits.

Properly managed ponds can add beauty to the landscape. Pond management begins with proper planning and construction, followed by continued maintenance. The greatest example of poor planning is the construction of a pond that won't hold water. To prevent this, soil surveys, the Soil Conservation Service or county extension agents should be consulted to determine what soil types are present and the depth of the water table. It is important to carefully plan pond and waterway construction with consideration given to future objectives and management plans. Dominating plants can be controlled with biocontrols, herbicides, mechanical harvesting or pond drawdown. The herbicides chosen should be labeled for aquatic use. The herbicide label should be checked to see if the herbicide prohibits the use of the treated water for fishing, swimming or irrigation. Because regulations vary from state to state, the necessary permits should be obtained and all label instructions should be followed. (Mertz-PTT)
W90-03271

USE OF INFLATABLE WEIRS FOR WATER LEVEL REGULATION.
Floecksmuhle Energietechnik G.m.b.H., Aachen (Germany, F.R.).
For primary bibliographic entry see Field 8A.
W90-03310

RUNOFF, SEDIMENT AND NUTRIENT LOSSES FROM VARIOUS TILLAGE SYSTEMS OF COTTON.
Auburn Univ., AL. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W90-03377

RUNOFF AND EROSION CONTROL WITH HILL FARMING IN THE SUB-COASTAL AP-ENNINES CLIMATE.
Palermo Univ. (Italy). Faculty of Agriculture.
For primary bibliographic entry see Field 4D.
W90-03378

EFFICIENCY OF SUBSOILING AND SUBSUR-FACE DRAINAGE IN HEAVY ALLUVIAL SOILS OF THE G.D.R.
Forschungszentrum fuer Bodenfruchtbarkeit Muencheberg (German D.R.).
L. Muller.
Soil and Tillage Research SOTRD5, Vol. 12, No.

2, p 121-134, Aug 1988. 8 fig, 4 tab, 29 ref.

Descriptors: *Drainage engineering, *Drainage ditches, *Rainfall impact, *Clays, *Mole drainage, *Soil porosity, Soil properties, Field tests.

The durability of mole channels, disruption zones and backfills of rain trenches was observed and the traction requirements of rigid tines were determined, during long-term field trials on alluvial clay soils. Mole channels formed above the water-table and having an effective top depth of greater than or equal to 0.55 m will be ascertainable as cavities over 3-7 years, and thereafter as zones of increased horizontal permeability. In disruption zones, improved water permeability at a depth of greater than or equal to 0.45 m continued for more than 54 months. After 20 years, backfilled soil tends to be less permeable than the adjacent undisturbed soil. The causes of differences in durability were analyzed and results used to determine an efficient installation method. It is recommended that pipe drainage with permeable backfill be applied together with mole loosening (Maulwurflockerung). The combination should be adapted to local field conditions. (Author's abstract)
W90-03379

INCREASING DAMMING OF THE PARANA BASIN AND ITS EFFECTS ON THE LOWER REACHES.
Consejo Nacional de Investigaciones Cientificas y Tecnicas, Buenos Aires (Argentina).
For primary bibliographic entry see Field 6G.
W90-03507

EFFECT OF STREAM REGULATION ON POP-ULATION PARAMETERS OF ATLANTIC SALMON (SALMO SALAR L.) IN THE RIVER LAERDALSELVA, WESTERN NORWAY.
Oslo Univ. (Norway). Lab. for Freshwater Ecology and Inland Fisheries.
For primary bibliographic entry see Field 6G.
W90-03508

SEDIMENT DEPOSITION IN CUTOFF MEAN-DER BENDS AND IMPLICATIONS FOR EF-FECTIVE MANAGEMENT.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 2J.
W90-03511

OPTIMAL REAL-TIME FORECASTING AND CONTROL OF RESERVOIR HYDROSYSTEMS USING REMOTE AND ON-SITE SENSORS, VOLUME I: FORECASTING RESERVOIR IN-FLOWS.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2A.
W90-03552

OPTIMAL REAL-TIME FORECASTING AND CONTROL OF RESERVOIR HYDROSYSTEMS USING REMOTE AND ON-SITE SENSORS, VOLUME II: RESERVOIR CONTROL.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 2A.
W90-03553

PLANNING MODEL FOR THE CONTROL AND TREATMENT OF STORMWATER RUNOFF THROUGH DETENTION STORAGE.
Puerto Rico Univ., Mayaguez. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-03561

4B. Groundwater Management

COMBINING FLOW SIMULATION AND OP-TIMIZATION FOR DYNAMIC MANAGE-MENT OF RELIEF WELLS.

Group 4B—Groundwater Management

Alberta Environment, Edmonton. Technical Services Div.
T. S. Chau.
Advances in Water Resources AWREDI, Vol. 12, No.1, p 26-36, March 1989. 6 fig, 3 tab, 26 ref.

Descriptors: *Subsurface drainage, *Model studies, *Mathematical models, *Relief wells, *Hydrostatic pressure, *Simulation analysis, *Systems analysis, Impervious soils, Sand, Gravel, Reservoirs, Rivers, Surface water, Flow discharge, Permeability, Management planning, Hydraulic structures, Aquifers, Optimization, Groundwater movement, Simulation analysis, Site selection, Sensitivity analysis, Transmissivity, Weil capacity, Drawdown.

Many dams and levees are founded on a thin layer of relatively impervious soil underlain by a deep layer of pervious sands and gravels. Induced by the hydrostatic pressure in the reservoir or river, water flows from the surface water body through the permeable layer towards the area landward of the hydraulic structure. This can produce high pressure in the permeable layer landward of the structure such that the submerged weight of the overlying stratum is insufficient to contain it. A management model has been developed and tested for analyzing pressure relief well systems near hydraulic structures. The management problem was formulated using the mixed integer programming optimization technique. Groundwater flow dynamics were incorporated into the optimization formulation using response functions generated with a flow simulation model. The stability of soils was considered by requiring acceptable head bounds at potential heaving locations. The management model selects well sites and determines optimal operation schedules for the relief wells. The model was demonstrated with two hypothetical examples to illustrate the tradeoffs between system parameters and the system performance. Sensitivity studies of system parameters were performed, respectively, on aquifer transmissivity, minimum drawdown, and well capacity. (Author's abstract)
W90-02548

HYDROGEOLOGY.
For primary bibliographic entry see Field 2F.
W90-02866

REGION 7, CENTRAL ALLUVIAL BASINS.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 2A.
W90-02876

THREE-DIMENSIONAL FINITE ELEMENT GROUNDWATER MODEL FOR THE RIVER RHINE RESERVOIR KEHL/STRASBOURG.
Lahmeyer International G.m.b.H., Frankfurt am Main (Germany, F.R.).
For primary bibliographic entry see Field 7C.
W90-02995

NUMERICAL MODELING OF HOT WATER STORAGE IN AQUIFER BY FINITE ELEMENT METHOD.
Ecole Nationale Superieure d'Arts et Metiers, Paris (France).
For primary bibliographic entry see Field 2F.
W90-03083

MODELLING THE REGIONAL HEAT BUDGET IN AQUIFERS.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie.
For primary bibliographic entry see Field 2F.
W90-03084

THERMAL ENERGY STORAGE MODEL FOR A CONFINED AQUIFER.
Nanjing Univ. (China). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-03085

OPTIMAL OPERATION OF A RESERVOIR SYSTEM WITH NETWORK FLOW ALGORITHM.
Universidade Estadual de Campinas (Brazil). Dept. de Engenharia de Sistemas.
P. B. Correia, and M. G. Andrade.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 399-404, 1 fig, 8 ref.

Descriptors: *Brazil, *Reservoirs, *Networks, *Resources management, *Hydrologic models, Optimization, Hydroelectric power, Seasonal distribution, Irrigation, Instream flow, Water supply, Water quality management, Mathematical models, Sao Paulo, Performance evaluation.

The problem of optimal operation of a multiple-use reservoir system in the state of Sao Paulo, Brazil, is discussed. The operation of this system needs to consider conflicting objectives (water supply, electrical energy production, irrigation, and minimum and maximum outflow constraints due to water quality and flood control problems, respectively). The problem was formulated as a network flow optimization model with a parametric objective function. The solution consists of reservoir optimal daily operation rules and the curve representing the trade-off between water supply and electrical energy production. The water quality resulting from optimal operation was analyzed and flow levels needed to maintain desired water quality were determined. During the rainy season, objectives were obtained totally and during the dry season the maximum water supply demand that the system could maintain, without infringing on the minimum outflow restrictions, was 15 cu m/sec. In all cases studied, the flows of the rivers exceeded the critical values necessary to maintain water quality. (See also W90-03036) (Rochester-PTT)
W90-03094

MATHEMATICAL SIMULATION OF HYDROLOGIC REGIME OF CHAOHUA SPRING IN MIXIAN COUNTY.
Nanjing Univ. (China).
For primary bibliographic entry see Field 2F.
W90-03115

APPLICATION OF NUCLEAR TECHNIQUES TO EXPLOIT VUGULAR PORE WATER IN RED BEDS, SICHUAN BASIN.
Institute of Applied Nuclear Technology of Sichuan, China.
For primary bibliographic entry see Field 2F.
W90-03139

CHARACTERISTICS AND RESOURCE ASSESSMENT OF THE THERMAL GROUNDWATER FROM THE LOWER TRIASSIC SERIES KARST IN CHONGQING XIAOQUAN HOTEL AREA.
Nanjiang Hydrogeological and Engineering Geological Party, Sichuan, China.
For primary bibliographic entry see Field 2F.
W90-03159

KARST GROUNDWATER INRUSH AND ITS PREVENTION AND CONTROL IN COAL MINES IN CHINA.
Institute of Geology and Exploration, Xian (China).
For primary bibliographic entry see Field 2F.
W90-03171

ALMOST DEVELOPED TECHNIQUE OF KARST COLLAPSE PREVENTION DURING MINE DRAINAGE.
China Univ. of Geosciences, Beijing, China.
For primary bibliographic entry see Field 2F.
W90-03180

FORMATION OF GYPSUM KARST COLLAPSE-COLUMN AND ITS HYDROGEOLOGICAL SIGNIFICANCE.
State Bureau of Mineral Reserves, Beijing (China).

For primary bibliographic entry see Field 2F.
W90-03184

IDENTIFICATION OF SUBSURFACE DRAIN LOCATIONS WITH GROUND-PENETRATING RADAR.
Agriculture Canada, Fredericton (New Brunswick). Research Station.
For primary bibliographic entry see Field 7B.
W90-03287

4C. Effects On Water Of Man's Non-Water Activities

CONSEQUENCES OF SEA LEVEL RISE: IMPLICATIONS FROM THE MISSISSIPPI DELTA.
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 2L.
W90-02552

CHANGES IN SALMON SPAWNING AND REARING HABITAT FROM INCREASED DELIVERY OF FINE SEDIMENT TO THE SOUTH FORK SALMON RIVER, IDAHO.
W. S. Platts, R. J. Torquemada, M. L. McHenry, and C. K. Graham.
Transactions of the American Fisheries Society TAFSAI, Vol. 118, No. 3, p 274-283, May 1989. 4 fig, 3 tab, 33 ref.

Descriptors: *Logging, *Spawning, *Sediment discharge, *Salmon, South Fork Salmon River, Idaho, Flood flow, Sedimentation.

Levels of surface and subsurface fine sedimetn (<4.75 mm in diameter) were measured annually from 1965 to 1985 in spawning and rearing areas for chinook salmon Onchorynchus tschawtscha and steelhead O. mykiss (formerly Salmo gairdneri) in the South Fork Salmon River, Idaho. Between 1950 and 1965, logging and road construction, in combination with large storm events of 1964 and 1965, resulted in the delivery of increased amounts of fine sediments to the area in 1966 and 48% of the volume in 1969, respectively. A logging moratorium initiated in 1965, coupled with natural recovery and watershed rehabilitation, led to significant decreases in the amounts of fine sediments delivered to and stored in the South Fork Salmon River; this reduction led to a limited resumption of logging operations within the watershed in 1978. By 1985, surface and subsurface sediment levels in chinook salmon spawning areas averaged 19.7% of the surface area and 24.5% of the volume, respectively. However, additional recovery to prelogging fine sediment levels is probably contingent on both further watershed recovery and the occurrence of flood flows capable of transporting material downstream. An equilibrium between incoming sediment from the watershed and outgoing sediment from the river appears to have been reached under flow regimes that have occurred since 1975. (Author's abstract)
W90-02689

CATCHMENT DISTURBANCE INFERRED FROM PALEOLIMNOLOGICAL STUDIES OF THREE CONTRASTED SUB-HUMID ENVIRONMENTS IN MOROCCO.
University Coll., London (England). Palaeoecology Research Unit.
R. J. Flower, A. C. Stevenson, J. A. Dearing, I. D. L. Foster, and A. Airey.
Journal of Paleolimnology, Vol. 1, No. 4, p 293-322, 1989. 15 fig, 9 tab, 47 ref.

Descriptors: *Environmental effects, *Paleolimnology, *Sediments, *Land use, *Subhumid climates, *Morocco, Catchment areas, Cores, Erosion, Geochemistry, Magnetic studies, Diatoms, Pollen.

The degree of catchment disturbance at three sites in Morocco was determined from sediment cores. Magnetic, geochemical, pollen, and diatom studies

of cores from all three sites were compared with modern field-survey data. Despite failure to date the beginning of inferred catchment disturbance, sediment cores for Dayat-er-Roumi and Dayat Affougah provided clear evidence of recent and major erosion of catchment soils. The recent history of the Dayat-er-Roumi catchment was one of continuous agricultural disturbance upon which was superimposed the effects of a sequence of wetland drainage operations represented by peaks in the magnetic profiles. The pollen present in the samples suggested soil erosion from catchment deforestation at Dayat Affagougah. Diatom communities have not yet stabilized at either of these sites but declining sediment accumulation rates and diminished soil inwash indicated partial recovery from past disturbances. The Lac Azigza had a relatively pristine cedar forest remaining and a low level of human activity in the catchment. Although the site had partial forest clearance, possibly in the 17th century, the overall picture since then was one of environmental stability. The pollen record at Lac Azigza indicated increased sheep grazing in the catchment area during the post-1963 period. (Cutty-PTT)
W90-02731

MODELING THE EFFECTS OF AMAZONIAN DEFORESTATION ON REGIONAL SURFACE CLIMATE: A REVIEW.

National Center for Atmospheric Research, Boulder, CO.
R. E. Dickinson.
Agricultural and Forest Meteorology AFMEEB, Vol. 47, No. 2-4, p 339-347, Sep 1989. 5 fig, 17 ref.

Descriptors: *Climatology, *Forests, *Amazon River, Model studies, Micrometeorology, Deforestation, Rainfall.

Conversion of a large fraction of the Amazon to shorter cover is expected to have significant climatic consequences. Evaluation of these consequences; however, requires modeling the micrometeorology of the forest canopy, plus scaling up from the local scales of individual sites and convective storms to the scales of Global Climate Models (GMCs). The model of Dickinson and Henderson-Sellers indicates the important effects of deforestation, especially a decrease in evapotranspiration and an increase in surface temperatures. The model's estimation of interception losses; however, appears exaggerated, especially during the wet season, because of an excess in model solar radiation at the surface and because of the dissimilarity between the temporal structure of local rainfall and that generated at a model grid point. These defects are likely to exaggerate the change in model interception. It is also apparent that a GCM integration of $>$ or $=$ to 3-4 years may be necessary to establish the consequences of the deforestation for regional and global climate. (Author's abstract)
W90-02783

WATER RESOURCES AND EFFECTS OF POTENTIAL SURFACE COAL MINING ON DISSOLVED SOLIDS IN HANGING WOMAN CREEK BASIN, SOUTHEASTERN MONTANA.

Geological Survey, Helena, MT. Water Resources Div.
M. R. Cannon.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4047, August 1989. 82p, 9 fig, 4 pl, 14 tab, 56 ref.

Descriptors: *Coal mine effects, *Geohydrology, *Water pollution sources, *Montana, Hydrology, Surface coal mining, Water quality.

Groundwater resources of the Hanging Woman Creek basin, Montana include Holocene and Pleistocene alluvial aquifers and sandstone, coal, and clinker aquifers in the Paleocene Fort Union Formation. Surface water resources are composed of Hanging Woman Creek, its tributaries, and small stock ponds. Dissolved-solids concentrations in groundwater ranged from 200 to 11,00 mg/L. Generally, concentrations were largest in alluvial aquifers and smallest in clinker aquifers. Near its

mouth, Hanging Woman Creek had a median concentration of about 1,800 mg/L. Mining of the 20-foot to 35-foot-thick Anderson coal bed and 3-foot to 16-foot thick Dietz coal bed could increase dissolved-solids concentrations in shallow aquifers and in Hanging Woman Creek because of leaching of soluble minerals from mine spoils. Analysis of saturated-paste extracts from 158 overburden samples indicated that water moving through mine spoils would have a median increase in dissolved-solids concentration of about 3,700 mg/L, resulting in an additional dissolved-solids load to Hanging Woman Creek of about 3.0 tons/day. Hanging Woman Creek near Birney could have an annual post-mining dissolved-solids load of 3,415 tons at median discharge, a 47% increase from pre-mining conditions load. Post-mining concentrations of dissolved solids, at median discharge, could range from 2,380 mg/L in March to 3,940 mg/L in August, compared to mean pre-mining concentrations that ranged from 1,700 mg/L in July, November, and December to 2,060 mg/L in May. Post-mining concentrations and loads in Hanging Woman Creek would be smaller if a smaller area were mined. (USGS)
W90-02848

RELATION BETWEEN LAND USE AND GROUND-WATER QUALITY IN THE UPPER GLACIAL AQUIFER IN NASSAU AND SUFFOLK COUNTIES, LONG ISLAND, NEW YORK.

Geological Survey, Albany, NY. Water Resources Div.
D. A. V. Eckhardt, W. J. Flipse, and E. T. Oaksford.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 86-4142, 1989. 35p, 11 fig, 5 tab, 65 ref.

Descriptors: *Long Island, *New York, *Geohydrology, *Groundwater pollution, *Water quality, *Organic solvents, *Water pollution sources, Path of pollutants, Groundwater, Land use.

The chemical quality of groundwater in the upper glacial (water-table) aquifer beneath the 10 types of land-use areas of Nassau and Suffolk Counties, NY was examined to evaluate the effect of human activities on groundwater. The highest median chloride and total dissolved-solids concentrations were found in wells in high-density residential areas (more than five dwellings/acre), and the highest median nitrate, sulfate, and calcium concentrations were found in wells in agricultural and high density residential areas. Relatively low median concentrations of inorganic chemical constituents were found in wells in undeveloped and low-density residential areas (1 or fewer/acre): volatile organic compounds were rarely detected in these same areas. The highest concentrations and most frequent detection of volatile organic compounds were in industrial and commercial areas. The most commonly detected volatile organic compounds were 1,1,1-trichloroethane (24% of wells), tetrachloroethylene (20%), trichloroethylene (18%), chloroform (9%), and 1,2-dichloroethylene (5%). The spatial distributions of trichloroethylene, chloroform and other volatile organic compounds in the upper glacial aquifer are directly correlated with population density in the two-county area. (USGS)
W90-02861

FLOODS: HYDROLOGICAL, SEDIMENTOLOGICAL AND GEOMORPHOLOGICAL IMPLICATIONS.

For primary bibliographic entry see Field 2E.
W90-02963

FLOOD FREQUENCY AND URBAN-INDUCED CHANNEL CHANGE: SOME BRITISH EXAMPLES.

College of St. Paul and St. Mary, Cheltenham (England). Dept. of Geography and Geology.
For primary bibliographic entry see Field 2E.
W90-02968

RIVER CHANNEL CHANGES IN RESPONSE TO FLOODING IN THE UPPER RIVER DEE CATCHMENT, ABERDEENSHIRE, OVER THE LAST 200 YEARS.

College of St. Paul and St. Mary, Cheltenham (England). Dept. of Geography and Geology.
For primary bibliographic entry see Field 2E.
W90-02976

INTERACTIONS BETWEEN PB-ZN MINE OF GUTTURU PALA AND LOCAL GROUNDWATER RESOURCES (FLUMINESE, SARDINIA, ITALY).

Dept. Georisorse e Territorio, Torino, Italy.
M. Civita, P. Forti, G. Perna, and B. Turi.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1083-1088, 4 fig, 1 ref.

Descriptors: *Lead, *Zinc, *Mine drainage, *Groundwater movement, *Geohydrology, *Karst hydrology, *Italy, *Groundwater quality, *Karst, Heavy metals, Potable water, Irrigation water, Industrial water, Flow profiles.

In the northern part of the Iglesiente mining district, the Gutturu Pala geohydrological system of Italy is one of the most important sources for Pb and Zn in the European Economic Community. The host rock of the ore deposits is the carbonitic 'Gonnesa formation', lower cambrian in age. Ten sets of water samples were collected from all the springs of the area and from test holes in the +157 level of the Gutturu Pala mine. Standard chemical analyses were carried out on all these sets. Two separate dye tests were also conducted, pumping the tracer in two test holes at opposite sides of the +157 level. These tests gave positive results for both Pubuxinu and Gutturu Pala springs, proving their geohydrological connection with the mine as well as with each other. By using the known discharges for the three main springs, the average groundwater discharge was evaluated. This was on the order of 0.4 cu m/s, with peak flows of about 0.6 cu m/s. Average hydrochemical data define the water quality of the springs as: being of 'good quality' for potable use; 'unlimited' for irrigation use; and 'good' for industrial use. On the basis of the characteristic ionic ratios, a similarity was found between the waters from the +80 level and those of the springs to the southeast. Dye tracing tests done from the Su Pitzianti sinkhole, at the eastern side of the carbonate structure close to the Arenas mine, gave positive results in all the springs and, after a longer time interval, also in the +80 gallery, making evident the interconnection between all the systems feeding the springs. (See also W90-03104) (Lantz-PTT)
W90-03172

KARST WATER-BEARING SALIENT FEATURES IN WANGFENG COLLIERY, JIAOZUO COAL MINE.

Jiaozuo Coal Mine Administration (China).
For primary bibliographic entry see Field 2F.
W90-03175

PRACTITIONER'S HANDBOOK ON THE MODELLING OF DYNAMIC CHANGE IN ECOSYSTEMS.

Institute of Terrestrial Ecology, Grange over Sands (England). Merlewood Research Station.
For primary bibliographic entry see Field 6G.
W90-03198

ENVIRONMENTAL INFLUENCES ON THE OYSTER INDUSTRY ALONG THE WEST COAST OF FLORIDA.

Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 6G.
W90-03263

Group 4C—Effects On Water Of Man's Non-Water Activities

HYDRAULIC ENGINEERING: GLOBAL CHALLENGE.
Polytechnic Univ., Brooklyn, NY.
For primary bibliographic entry see Field 6G.
W90-03329

AQUATIC HYPHOMYCETE COMMUNITIES IN CLEAR-CUT AND WOODED AREAS OF AN ILLINOIS STREAM.
Illinois Univ. at Urbana-Champaign. Dept. of Plant Biology.
A. A. Metwalli, and C. A. Shearer.
Transactions of the Illinois Academy of Science TISAAH, Vol. 82, No. 1-2, p 5-16, 1989. 2 fig, 4 tab, 30 ref.

Descriptors: *Forest hydrology, *Environmental impact, *Fungi, *Decomposing organic matter, *Detritus, *Aquatic fungi, *Streams, Leaves, Clear-cutting, Species diversity, Decomposition, Illinois, Forests.

Aquatic hyphomycete communities in wooded and clear-cut areas of Jordan Creek, Vermilion County, Illinois, were compared using leaf pack baits and membrane filtration of stream water. Number of species per unit substrate, species richness, diversity, number of conidia per liter of stream water, and degree of colonization of substrate were all greater in wooded areas and adjacent downstream clear-cut sites than in an upstream clear-cut site. Wooded patches on clear-cut streams could serve to maintain diversity and inoculum levels of aquatic fungal decomposer communities. (Author's abstract)
W90-03383

FISH DISTRIBUTION IN RICHLAND CREEK, AN URBANIZING STREAM BASIN IN SOUTHWESTERN ILLINOIS.
Southern Illinois Univ. at Edwardsville. Dept. of Biological Sciences.
J. E. Thomerson, and T. M. Keevin.
Transactions of the Illinois Academy of Science TISAAH, Vol. 82, No. 1-2, p 71-84, 1989. 1 fig, 1 tab, 10 ref.

Descriptors: *Urban hydrology, *Urban areas, *Streams, *Fish populations, *Illinois, *Water pollution effects, Water pollution sources, Wastewater pollution, Agricultural runoff, Mine drainage, Nonpoint pollution sources, Richland Creek, Madtom, Orangethroat darter.

Richland Creek drains 238 square miles of the Greater St. Louis Metropolitan Area in southwestern Illinois. It is subject to mine runoff, urban, and agricultural pollution. Sewage treatment plant discharges are the only major point sources the Basin. A total of 27 fish collections made in the basin included 32 species. The main channel is degraded but Prairie du Long Creek retains six species characteristic of good quality, high gradient streams. Records of the slender madtom and orangethroat darter are significant range extensions in Illinois. (Author's abstract)
W90-03384

CHANGES IN PHYSICAL PROPERTIES OF YOUNG AND OLD VOLCANIC SURFACE SOILS IN COSTA RICA AFTER CLEARING OF TROPICAL RAIN FOREST.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Geology.
E. J. A. Spaans, G. A. M. Baltissen, J. Bouma, R. Miedema, and A. L. E. Lansu.
Hydrological Processes HYPRE3, Vol. 3, No. 4, p. 383-392, October-December 1989. 5 fig, 1 tab, 17 ref.

Descriptors: *Environmental impact, *Clear-cutting, *Rain forests, *Tropical regions, *Costa Rica, *Soil physical properties, *Hydraulic conductivity, Soil water, Hydraulic properties, Soil structure, Soil moisture retention, Soil porosity, Pastures, Forests.

Large areas of tropical rain forests are being cleared and used for agricultural purposes. As a result, fragile soil structure degrades which alters

soil hydraulic properties. Soil physical methods and micromorphometrical analysis were used to analyze effects of changes in vegetation on soils of different ages in Costa Rica. Measurements were made in topsoils of a relatively old Humoxic Tropohumult and of a relatively young Oxic Humitropept, both under forest and under pasture. The crust test was used to measure hydraulic conductivities in relation to pressure head (h). Moisture retention data were obtained by measuring outflow from undisturbed core samples placed in porous cups at certain negative pressure heads. Micromorphometric analysis of thin sections supplied quantitative descriptions of macroporosity patterns and pore types. Saturated hydraulic conductivity of the Humult decreased from 1000 cm/day under forest to 50 cm/day under pasture. Macroporosity of the forest topsoil consisted mainly of compound packing voids. In the pasture topsoil predominantly vughs and more planar voids were present and macroporosity was significantly lower. The saturated hydraulic conductivity was equal at 70 cm/day under both types of vegetation of the Tropept. Compound packing voids as well as vughs were present under both forest and pasture. Under pasture more planar voids appeared and macroporosity decreased significantly. Both total porosity and bulk density, before and after clearing of forest, were not significantly different in the two soil types. Obviously, puddling occurred in both soil types. Structure degradation in the relatively old Humult was more severe in a shorter time than in the relatively young Tropept over a longer time span. (Author's abstract)
W90-03506

4D. Watershed Protection

ATTEMPT TO SYNTHESIZE KNOWLEDGE ON MOUNTAIN EROSION AND TORRENTIAL HYDRAULICS (ESSAI DE SYNTHESE DES CONNAISSANCES EN EROSION ET HYDRAULIQUE TORRENTIELLE).
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Saint-Martin d'Heres (France). Grenoble Group.
For primary bibliographic entry see Field 2J.
W90-02553

DETERMINATION OF THE PERMISSIBLE VELOCITIES IN CANALS.
For primary bibliographic entry see Field 8B.
W90-02557

PRESERVATION AND RESTORATION OF THE WATER RESOURCES OF THE ARAL SEA--AN URGENT NATIONAL ECONOMIC PROBLEM.
For primary bibliographic entry see Field 5G.
W90-02692

SOLVING A STREAMBANK STABILIZATION PROBLEM.
Metropolitan St. Louis Sewer District, MO.
For primary bibliographic entry see Field 4A.
W90-02737

TILLAGE AND RAINFALL EFFECTS ON RANDOM ROUGHNESS: A REVIEW.
Agricultural Research Service, Big Spring, TX.
For primary bibliographic entry see Field 3F.
W90-02775

INTERFLOW IN A TILLED, CRACKING CLAY SOIL UNDER SIMULATED RAIN.
Queensland Dept. of Primary Industries, Toowoomba (Australia). Wheat Research Inst.
R. J. Loch, E. C. Thomas, and T. E. Donnollan.
Soil and Tillage Research SOTRD5, Vol. 9, No. 1, p 45-63, Jan 1987. 8 fig, 1 tab, 37 ref.

Descriptors: *Cultivated lands, *Australia, *Soil erosion, *Soil water, *Interflow, Rainfall, Surface runoff.

On the uplands of the Darling Downs, runoff and erosion during summer fallows are a major prob-

lem. Interflow has been reported in tilled catchments in this area and might be controlled to reduce surface runoff and soil erosion. In view of the lack of data on interflow in tilled soils, rates of interflow in a tilled soil for a range of stubble mulch rates are reported, and the mechanisms of observed flow described. Plots 22.5 x 4 m carrying surface mulches of 3, 2, 1 and 0.1 t/ha wheat stubble were prepared on a shallow black, cracking clay on 6% slope. The plots were pre-wet, and then simulated rain at 95 mm/h was applied (using a rainulator) for a 50-min test period. Perched water tables developed in the tilled layer and interflow was clearly visible flowing out beneath the collection gutter at the downslope end of the plot. Interflow rates were calculated from: (a) measurements of surface runoff at the rainulator plots at the end of the 50-min test periods; and (b) measurements of steady, deep infiltration rate for the site made using a rotating disc rainfall simulator. The interflow rates calculated for the rainulator plots were significantly related to stubble rates. Stubble appeared to increase interflow by reducing sediment loads in runoff water, thereby reducing the clogging of large voids in the tilled layer by sediment. Large, interconnected voids in the tilled layer must have been the major pathway for interflow. (Author's abstract)
W90-02776

INFILTRATION MEASUREMENTS WITH DOUBLE-RING INFILTROMETERS AND A RAINFALL SIMULATOR UNDER DIFFERENT SURFACE CONDITIONS ON AN OXISOL.
Soil Management and Conservation Department, Agricultural Research Institute of Parana, Brazil.
For primary bibliographic entry see Field 2G.
W90-02777

RIPRAP DESIGN.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W90-03334

RUNOFF AND EROSION CONTROL WITH HILL FARMING IN THE SUB-COASTAL APENNINES CLIMATE.
Palermo Univ. (Italy). Faculty of Agriculture.
G. Chisci, and V. Boschi.
Soil and Tillage Research SOTRD5, Vol. 12, No. 2, p 105-120, Aug 1988. 9 fig, 6 tab, 12 ref.

Descriptors: *Agricultural runoff, *Erosion control, *Soil erosion, *Cultivated lands, *Cultivation, *Runoff coefficient, Slope stability, Alfalfa, Ditches, Italy, Clays, Contours.

In the hilly sub-coastal Apennines climate, farming with new soil-management systems in the last 30 years has increased runoff and soil erosion. The main features of such a change are crop specialization, shaping and enlargement of the fields, tilling up and down the slope, and removal of mechanical structures, used for water management and erosion control. The effectiveness of lucerne ley and contour ditches in reducing runoff and soil erosion was evaluated in a clay, hilly area of the Northern-Central Apennines (Guiglia, Modena, Italy). Lucerne ley in the rotation was very effective in controlling upland runoff and reducing soil erosion. The runoff coefficient in plots with arable crops was 0.30 and soil loss was 9 million gm/ha/yr, while in the lucerne ley plots the runoff coefficient was 0.21 and the soil loss was 3 million gm/ha/yr. Very little was accomplished in water management and erosion control by tilling on the contour instead of up and down the slope. In fact, the runoff coefficient was 0.14 for contour tilling and 0.12 for up and down the slope. Soil loss was 2.4 million gm/ha/yr for contour tilling and 2.6 million gm/ha/yr for plowing up and down the slope. On the other hand, ditching on the contour reduced the runoff coefficient form 0.25 to 0.16 and the soil loss from 38.3 to 1.7 million gm/ha/yr on fields with arable summer crop. However, in very rainy years, ditching on the contour was not enough to control runoff and soil erosion in arable land. During this type of season the runoff coeffi-

cient was 0.37 and soil loss 16.5 million gm/ha/yr. In the same years, a combination of ditching on the contour and lucerne ley gave much better protection, reducing the runoff coefficient to 0.19 and the soil loss to 2 million gm/ha/yr. (Author's abstract) W90-03378

SEDIMENT DEPOSITION IN CUTOFF MEANDER BENDS AND IMPLICATIONS FOR EFFECTIVE MANAGEMENT.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 2J.
W90-03511

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

DETERMINATION OF ARSENIC (III/V) IN AQUEOUS SAMPLES BY NEUTRON ACTIVATION ANALYSIS AFTER SEQUENTIAL COPRECIPITATION WITH DIBENZYLDITHIOCARBAMATE.
Netherlands Energy Research Foundation ECN, Petten.
J. T. Van Elteren, H. A. Das, C. L. De Ligny, and J. Agterdenbos.
Analytica Chimica Acta ACACAM, Vol. 222, No. 1, p 159-167, July 1 1989. 5 fig, 4 tab, 7 ref.

Descriptors: *Neutron activation analysis, *Water analysis, *Chemical analysis, *Pollutant identification, *Arsenic, Chemical properties, Heavy metals, Membrane filters, Sensitivity analysis, Detection limits, Tracers.

A simple and sensitive method for distinguishing between As(III) and As(V) is presented. It is based on sequential coprecipitation with dibenzyldithiocarbamate (DBDTC) of As (III) and with a mixture of potassium iodide and thiosulfate. The precipitates are collected successively on 0.45-micron membrane filters and arsenic is determined by neutron activation of the filters and subsequent gamma-spectrometry. Optimum conditions for the two steps of the sequential coprecipitation technique were determined using 74As(III) and 74As(V) tracers. Under the optimized conditions some other heavy metal tracers were applied to study the selectivity of the method; of these, Cd and Fe were quantitatively and Ag and Zn partly recovered. The accuracy of the method was checked by determination of the total arsenic concentration in some water reference materials by applying the second step of the coprecipitation technique. The values found were well within the certified ranges. The applicability of the method to the speciation of arsenic in a fresh water sample is demonstrated. As(III) and As(V) could be determined with relative standard deviations of 3 and 5%, respectively, and a detection limit of 0.02 micrograms/L. Investigation of the behavior of some other arsenic species, e.g., monomethylarsonic acid (MMAA) and dimethylarsinic acid (DMAA), in the sequential coprecipitation technique, showed that neither MMAA nor DMAA is coprecipitated in the first step; in the second step, MMAA is coprecipitated quantitatively whereas DMAA is not coprecipitated at all. This implies that MMAA interferes in the determination of As(V). (Author's abstract)
W90-02595

IMPROVED SEPARATIONS PROCEDURES FOR ISOLATING 2,3,7,8-TCDD AND 2,3,7,8-TCDF FROM CHEMICALLY-COMPLEX AQUEOUS AND SOLID SAMPLE MATRICES AND FOR DEFINITIVE QUANTITATION OF THESE ISOMERS AT PPQ TO PPT CONCENTRATIONS.
Wright State Univ., Dayton, OH. Dept. of Chemistry.
T. O. Tiernan, J. H. Garrett, J. G. Solch, D. J. Wagel, and G. F. VanNess.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 93-

100, 1989. 3 fig, 3 tab, 5 ref.

Descriptors: *Water analysis, *Chemical analysis, *Dioxins, *Dibenzofurans, *Pollutant identification, *Pulp wastes, *Kraft mills, *Aromatic compounds, *Chlorinated hydrocarbons, Isomers, Wastewater, Wastewater disposal, Mass spectrometry, Analytical methods.

A program has been underway to investigate the extent of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) contamination at sites throughout the U.S. This program identified a previously unsuspected source of 2,3,7,8-TCDD contamination, namely, certain types of pulp and paper mills. An analytical procedure has been developed and validated for quantitatively measuring 2,3,7,8-TCDD and 2,3,7,8-tetrachlorodibenzofuran (TCDF) present at parts-per-trillion (ppt) to parts-per-quadrillion (ppq) concentrations in various paper manufacturing process and wastewater samples. Traditionally-implemented liquid chromatographic methods were failing to remove components of the sample that yield mass spectral responses at the same nominal ion masses as the target analytes. Therefore, the elution characteristics of the basic alumina column for a typical paper mill sample extract spiked with known quantities of all 38 TCDF isomers were determined. It was found that by applying a modified elution sequence, in which the alumina column is first eluted with 10 mL of 3% methylene chloride-in-hexane, followed by 15 mL of 20% methylene chloride-in-hexane, and finally, with 15 mL of 50% methylene chloride-in-hexane, collecting only the last eluate for analysis, the 2,3,7,8-TCDF isomer could be recovered quantitatively. This modified alumina column elution procedure also results in the presence of significantly lower quantities of interfering chemical residues in the column eluate fraction that is collected for TCDD/TCDF analyses. Results with this method showed that desired detection limits can generally be achieved with this method and the various criteria specified for the analytical data, as described earlier, are now fully satisfied. However, even with the improved procedures, the use of high resolution mass spectrometry (1:6500 resolution) was found to be necessary to obtain the desired detection limits for a few types of paper mill aqueous samples. (Friedmann-PTT)
W90-02596

DETERMINATION OF POLYCHLORINATED DIBENZO-DIOXINS AND DIBENZOFURANS IN ENVIRONMENTAL SAMPLES USING HIGH RESOLUTION MASS SPECTROMETRY.
Environmental Protection Agency, Kansas City, KS. Environmental Services Div.
R. D. Kleopfer, R. L. Greenall, T. S. Viswanathan, C. J. Kirchmer, and A. Gier.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 109-118, 1989. 2 fig, 3 tab, 7 ref.

Descriptors: *Water analysis, *Chemical analysis, *Organic compounds, *Aromatic compounds, *Dioxins, *Dibenzofurans, *Chlorinated hydrocarbons, *Pollutant identification, *Organic compounds, *Organic pesticides, *Mass spectrometry, *Gas chromatography, Water pollution sources, Sampling, Analytical methods.

Environmental samples were analyzed for polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurnas (PCDFs) by a multiple internal standard isotope-dilution high-resolution gas chromatography/high-resolution mass spectrometry (HRGC/HRMS) method. Human health risk was assessed from an environmental incident or a suspected hazardous waste site by determining congener concentrations. PCDD and PCDF congener profiles were constructed for used in identifying pollution sources and in determining the appropriate regulatory and/or remedial actions. Good qualitative correlation was found between the PCDD/PCDF congener distribution found in the soil residue and that found in the smoke samples. Chlorinated furans were present in larger abundance than chlorinated dioxins in both air and soil samples. It was found that there is need for automated data reduction software, since up to 6 hours are required per sample for manual GC/MS data reduction methods. There is also a need for a

single gas chromatographic column with isomer specificity for all 15 toxic congeners. Although mass spectrometry has emerged as the analytical instrument for most PCDD and PCDF determination, the qualitative identification criteria for selected ion monitoring data vary widely from one laboratory to another. Extraction and cleanup steps also vary significantly. Some uniformity may be needed in these steps to obtain meaningful and comparable results for samples analyzed in different laboratories. (Friedmann-PTT)
W90-02597

METHOD 8290: AN ANALYTICAL PROTOCOL FOR THE MULTIMEDIA CHARACTERIZATION OF POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS BY HIGH-RESOLUTION GAS CHROMATOGRAPHY/HIGH-RESOLUTION MASS SPECTROMETRY.
Triangle Labs., Research Triangle Park, NC.
Y. Tondeur, W. F. Beckert, S. Billets, and R. K. Mitchum.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 119-131, 1989. 2 fig, 6 tab, 6 ref.

Descriptors: *Water analysis, *Chemical analysis, *Dioxins, *Dibenzofurans, *Pollutant identification, *Organic compounds, *Organic pesticides, *Mass spectrometry, *Aromatic compounds, *Gas chromatography, Analytical methods, Chlorinated hydrocarbons.

A new analytical protocol for the determination of polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) by high-resolution gas chromatography/high-resolution mass spectrometry (HRGC/HRMS) was developed. The new protocol, Method 8290, is a major step in an attempt of standardize an analytical method for PCDDs and PCDFs including the quality assurance and quality control requirements. The method can be used to measure 2,3,7,8-TCDD and total TCDDs, to identify and quantify all tetra through octachlorinated dibenzodioxins and dibenzofurans, or to determine, more specifically, the 15 2,3,7,8-substituted PCDD/PCDF congeners. The sample preparation which consists of a matrix-specific extraction followed by column chromatography, is preceded by the addition of the sample fortification solution consisting of the 13C-labeled PCDDs and PCDFs. Three types of column chromatography are specified, including a percolation of the extract through a column with acid-impregnated silica gel directly onto a column with neutral alumina, a Celite 545/AX-21 carbon column, and, to the final extract, 10 to 50 microL of a tridecane solution containing the two carbon-label recovery standards. Overall, the identification of PCDDs and PCDFs is achieved by applying a series of criteria that include the (relative) retention times (RRT) of the analytes and of the 13C-labeled standards, and which are compared with the RRTs obtained from the daily calibration checks. A mixture containing the first and last eluters for each class of chlorination is analyzed every 12 h to establish and document that the various PCDD/PCDF retention time windows are effectively monitored and that the GC column resolution is adequate. Documentation of the mass spectrometer resolving power is accomplished by recording the peak profile of the high-mass reference signal obtained during the peak-matching experiment, using the low-mass ion as a reference. (Friedmann-PTT)
W90-02598

ANALYSIS OF LARGE VOLUME WATER SAMPLES NEAR CHEMICAL DUMP SITES USING THE AQUEOUS PHASE LIQUID EXTRACTOR (APLE).
Ontario Ministry of the Environment, Rexdale. Lab. Services Branch.
R. E. Clement, S. A. Suter, and H. M. Tosine.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 133-140, 1989. 3 fig, 3 tab, 2 ref.

Descriptors: *Water analysis, *Chemical analysis, *Pollutant identification, *Aromatic compounds, *Chlorinated hydrocarbons, *Dioxins, *Dibenzofurans, *Chemical wastes, *Industrial wastes, Envi-

ronmental quality, Detection limits, Quantitative analysis, Niagara River, Canada.

A new, large volume water extraction device was used to determine concentrations of chlorinated dibenzo-p-dioxins (CDDs) and chlorinated dibenzofurans (CDFs) in surface water sampled near known chemical dump sites. A new device, the Aqueous Phase Liquid Extractor (APLE), was used to extract water for sampling. The APLE is capable of extracting up to 200 L water in a single batch process. This device is a 45 gallon drum constructed with a spray-bar across the top. The results using the APLE extraction device were similar to those obtained by conventional liquid/liquid extraction. Total CDD and CDF levels in the water were in the low ppb range, while levels in the suspended particulates centrifuged from the water were 10 times greater. The APLE sampling device proved to be very effective for detailed study of a specific area of suspected environmental contamination. By extracting 200 L samples, a sufficient concentration factor is obtained to either achieve extremely low limits of detection for target analytes, or to provide sufficient sample to achieve low detection limits for a number of different analytes. In this specific application, the APLE sampling/extraction device confirmed that high concentrations of CDDs/CDFs were entering the water at Pettit Flume on the Niagara River, Canada. The probable source of these compounds is former chemical dump sites that are known to exist in the vicinity. The total amount annually of CDDs/CDFs entering the Niagara River and eventually Lake Ontario from the source could be very high. (Friedmann-PTT)
W90-02599

LEVELS, TRENDS AND PATTERNS OF PCDDS AND PCDFS IN SCANDINAVIAN ENVIRONMENTAL SAMPLES.
Umea Univ. (Sweden). Dept. of Organic Chemistry.
For primary bibliographic entry see Field 5B.
W90-02607

MONITORING DIOXINS AND FURANS IN PRECIPITATION SAMPLES.
Ontario Ministry of the Environment, Rexdale. Lab. Services Branch.
C. Tshiro, R. E. Clement, M. Lusis, D. Orr, and N. Reid.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 777-782, 1989. 1 fig, 4 tab, 2 ref.

Descriptors: *Dioxins, *Dibenzofurans, *Pollutant identification, *Path of pollutants, *Aromatic compounds, *Chemistry of precipitation, *Air pollution, *Precipitation, *Air pollution, *Monitoring, Rainfall, Sampling, Particulate matter, Chlorinated hydrocarbons, Isotopic tracers, Canada.

The long-range transport of chlorinated dibenzo-p-dioxins (CDDs) and chlorinated dibenzofurans (CDFs) and their subsequent deposition via precipitation were investigated. Also, collection and storage methods for CDDs and CDFs were evaluated the their presence in precipitation samples collected in a remote Ontario location were determined. Two sample collection methods were used. The first method involved the use of a custom-designed heated sampler fitted with a five-gallon jug. In the second method, an XAD-2 resin cartridge was used in the sampler and the precipitation was allowed to percolate through the XAD-2 resin and into a 5 gallon jug. Each precipitation sample was collected over a four-week period. Samples were spiked with 13C-4CDD and 13C-8CDD prior to collection and with 13C-5CDD, 13C-6CDD, and 13C-7CDD prior to extraction. Low levels of the higher CDDs and CDFs were found in samples taken in the remote areas. The presence of higher chlorinated CDDs and CDFs in three precipitation collections from a rural Ontario location indicates that long-range transportation and deposition of airborne CDD and CDF does occur. This could account for the low background levels of 8CDD and 8CDF that were found in areas far removed from sites where dioxins and furans are known to exist. However, lower chlorinated CDD/CDF were not found in

any samples at detection limits as low as 4 ppq. At concentrations of 250 ppq, recoveries of all spiked congeners were good even after 6 months storage. However, recovery of 8CDD was observed to decrease significantly. At lower concentrations, recoveries of 1234-4CDD were still good, but variable recovery of 8CDD was observed. (Friedmann-PTT)
W90-02608

DETECTION OF DIOXINLIKE ACTIVITY IN FISH, SEDIMENT, AND SURFACE WIPES USING AN IN VITRO BIOASSAY.
New York State Dept. of Health, Albany. Wadsworth Center for Labs. and Research.
J. F. Gierthy, D. W. Lincoln, P. O'Keefe, R. Smith, and C. Meyer.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 793-800, 1989. 5 tab, 12 ref. NIEHS Grant no. ES03561.

Descriptors: *Dioxins, *Pollutant identification, *Bioassay, *Fish populations, *Organic compounds, New York, Sampling, Analytical methods, Fate of pollutants, Tissue analysis.

Fish, sediment and surface wipes collected from various sites in New York State were tested for dioxin-like activity using an in vitro bioassay (Flat-Cell Assay). The assay is based on 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)-induced alterations of post-confluent XBF mouse epithelial cell proliferation and morphology. This may be related to TCDD induction of epithelial differentiation, the cause of chloracne in humans. The bioassay results showed qualitative and general quantitative agreement with those generated by gas chromatographic-mass spectrometric analysis demonstrating the usefulness of the Flat-Cell Assay as a supplement to instrumental analysis. (Author's abstract)
W90-02609

ANALYSIS OF FOG SAMPLES FOR PCDD AND PCDF.
Battelle Columbus Div., OH.
For primary bibliographic entry see Field 5B.
W90-02611

CHLORINATED DIBENZO-P-DIOXINS (CDDS) AND DIBENZOFURANS (CDFS) IN EFFLUENTS AND SLUDGES FROM PULP AND PAPER MILLS.
Ontario Ministry of the Environment, Rexdale. Lab. Services Branch.
R. E. Clement, C. Tashiro, S. Suter, E. Reiner, and D. Hollinger.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 1189-1197, 1989. 2 fig, 4 tab, 5 ref.

Descriptors: *Path of pollutants, *Dioxins, *Dibenzofurans, *Aromatic compounds, *Pollutant identification, *Organic compounds, *Pulp wastes, *Kraft mills, *Sludge, *Industrial wastes, Effluents, Sampling, Isomers, Secondary wastewater treatment.

Sludges and treated effluents from various Ontario (Canada) pulp and paper plants were analyzed for chlorinated dibenzo-p-dioxins (CDDs) and dibenzofurnas (CDFs). Results showed that 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-4CDD) is a product of bleached kraft mills. The only CDD/CDF congeners found in more than one sludge sample were the tetrachlorinated CDDs (4CDD) and CDFs (4CDF) and octachlorinated CDD and CDF. Levels of 2,3,7,8-4CDD ranged from 170 to 370 ppt in the secondary treatment sludge from two bleached kraft mills. (Author's abstract)
W90-02618

SPECIFIC CONGENER PROFILES OF POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS IN BLUE MUSSEL IN OSAKA BAY IN JAPAN: AQUEOUS SOLUBILITIES OF PCDDS AND PCDFS.
Setsunan Univ., Neyagawa (Japan). Faculty of Pharmaceutical Sciences.
For primary bibliographic entry see Field 5B.
W90-02628

MORPHOLOGICAL AND BEHAVIORAL CHARACTERS IN MOSQUITOFISH AS POTENTIAL BIOINDICATION OF EXPOSURE TO KRAFT MILL EFFLUENT.
University of West Florida, Pensacola. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W90-02632

ROLE OF OLIGOCHAETES IN THE MANAGEMENT OF WATERS.
Rijksinstituut voor Natuurbeheer, Leersum (Netherlands).
P. F. M. Verdonschot.
Hydrobiologia HYDRB8, Vol. 180, p 213-227, August 15, 1989. 6 fig, 5 tab, 51 ref.

Descriptors: *Bioindicators, *Monitoring, *Pollutant identification, *Oligochaetes, Water quality, Species diversity, Sampling, Regulated flow.

To understand better the role of an aquatic oligochaete in the management of water quality, it was determined if oligochaetes were representative of water quality, if indices based on oligochaetes were widely applicable to access water quality, and if oligochaete assemblages were related to environmental factors other than organic pollution. It was found that if only one monitoring sample a year was taken in December, about 73% of the more common species were collected. Seasonality did not seem to affect the taxa collected except for forms in low presence, e.g., Nais. Several indices we used were not applicable to regulated streams. Oligochaete ordination procedures revealed only a partial picture of the environmental conditions of regulated streams. (Author's abstract)
W90-02665

TOXICOLOGICAL PROPERTIES OF THIO- AND ALKYLPHENOLS CAUSING FLAVOR TAINTING IN FISH FROM THE UPPER WISCONSIN RIVER.
Radian Corp., Research Triangle Park, NC.
For primary bibliographic entry see Field 5C.
W90-02671

METALS IN FISH SCALES COLLECTED IN LAKE OPEONGO, CANADA, FROM 1939-1979.
Department of Fisheries and Oceans, Burlington (Ontario).
M. G. Johnson.
Transactions of the American Fisheries Society TAFSAI, Vol. 118, No. 3, p 331-335, May 1989. 1 fig, 2 tab, 17 ref.

Descriptors: *Pollutant identification, *Bioindicators, *Lake sediments, *Fish, *Heavy metals, *Lake Opeongo, Copper, Mercury, Zinc, Cadmium. Trout, Bass, Tissue analysis, Time series analysis, Canada, Temporal distribution.

Time series (1939-1979) of metal concentrations in historical collections of scales from lake trout Salvelinus namaycush and smallmouth bass Micropterus dolomieuei from Lake Opeongo, Canada, were compared with temporal trends in metal concentration profiles in core samples of profundal lake sediment. There was no trend for zinc in scales. Elevated copper and mercury concentrations occurred early in the study period in both species. Elevated cadmium was found in the earliest year in smallmouth bass scales. Temporal trends in mercury (and possibly cadmium) in smallmouth bass scales probably were attributable to differences in fish weight among years. The data did not support the hypothesis that temporal trends in metal loadings entering lakes are reflected by fish tissue concentrations. (Author's abstract)
W90-02690

APPLICATION OF SHANNON-WIENER INDEX AS A MEASURE OF POLLUTION OF RIVER GANGA AT PATNA, BIHAR, INDIA.
Rajendra Agricultural Univ., Samastipur (India). Coll. of Fisheries.
V. G. Jhingran, S. H. Ahmad, and A. K. Singh.
Current Science CUSCAM, Vol. 58, No. 13, p

717-720, July 5 1989. 2 fig, 1 tab, 24 ref.

Descriptors: *India, *Macroinvertebrates, *Water pollution effects, *Ganga River, *Bioindicators, *Water quality, *India, *Species diversity, Shannon-Wiener index, Wastewater pollution.

Monthly variations of the Shannon-Wiener species diversity index (H) for benthic macroinvertebrates were recorded at three stations on river Ganga at Patna from July 1985 to June 1986. The Shannon-Wiener index varied from 0.346 to 1.238 at station III, and indicated severe environmental stress. The range at station II, 0.689 to 2.434, was indicative of an intermediate state of environmental pollution, and the range at station I, 0.798 to 2.608, reflects a comparatively low load of pollutants. The relatively constant values of the index at the station farthest downstream from Patna, reflects a relatively stabilized level of pollution from all effluent points, taking all reacting and interacting factors into account. The varying values of the index in different months at the other stations reflect a variable pollution load from individual effluent discharges interacting with abating forces such as dilution of water from various sources. (White-Reimer-PTT)
W90-02705

EVALUATION OF POLLUTION LOADINGS FROM URBAN NONPOINT SOURCES: METHODOLOGY AND APPLICATIONS.
National Water Research Inst., Burlington (Ontario).
J. Marsalek, and H. Y. F. Ng.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 3, p 444-451, 1989. 2 fig, 3 tab, 14 ref.

Descriptors: *Urban hydrology, *Great Lakes, *Water pollution sources, *Nonpoint pollution sources, *Urban runoff, Methodology, Applications, Loadings.

In preparation of remedial action plans for the St. Clair, Detroit, and St. Marys rivers, a planning-level methodology for evaluation of pollutant loadings from urban nonpoint sources was developed and applied in three Canadian cities: Sarnia, Sault Ste. Marie, and Windsor. This methodology uses computed annual volumes of runoff and mean constituent concentrations, estimated from field sampling, to produce estimates of annual pollutant loadings. For the constituents studied, the total loadings were predominantly from point sources in about three quarters of all cases. For some of the less common substances, occurring at low levels, the nonpoint sources contributed loadings which were comparable to or even higher than those from point sources. Such findings will be useful in the development of remedial action plans which need to focus on control of pollutant sources. (Author's abstract)
W90-02751

MONITORING OF TRACE ORGANIC CONTAMINANTS IN ATMOSPHERIC PRECIPITATION.
Inland Waters Directorate, Burlington (Ontario).
Water Quality Branch.
For primary bibliographic entry see Field 7B.
W90-02753

CONSUMPTION ADVISORIES FOR SPORT FISH IN THE GREAT LAKES BASIN: JURISDICTIONAL INCONSISTENCIES.
National Wildlife Federation, Ann Arbor, MI.
Great Lakes Natural Resource Center.
For primary bibliographic entry see Field 6E.
W90-02754

ANTHROPOGENIC IMPACTS ON SNIARDWY LAKE (POLAND).
Wroclaw Technical Univ. (Poland). Inst. of Inorganic Chemistry and Metallurgy of Rare Elements.
A. W. Jasinski.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 3, p 510-518, 1989. 1 fig, 7 tab, 20 ref.

Descriptors: *Limnology, *Water quality, *Water pollution sources, *Acidity, *Poland, *Lakes,

*Lake classification, Heavy metals, Soft-water lakes, Nutrients, Bioaccumulation, Fish tissues, Hydrogen ion concentration, Seasonal variation.

Sniardwy Lake, located in the northeastern part of the Great Masurian Lakes region, is Poland's largest inland lake. It is classified as a soft-water lake, and has relatively low nitrogen and phosphorus levels. Annual maximum values for chlorophyll (5.4 mg/L) and seston (6.7 mg/L) are relatively low. Pesticide pollution is of concern, and average levels of DDD and DDE were 2.2 x 0.00001 mg/L, respectively. Concentrations of mercury, lead, cadmium, zinc, and copper in the waters of Sniardwy Lake are near, but below, Polish and World Health Organization limits. Similarly, levels of heavy metals in the flesh of freshwater fish all were within acceptable limits (levels of these metals in livers of bream and eel were elevated, however). Levels of these metals in sediment were at least equal to, and often exceeded, levels found in fish tissue. According to polish standards, the waters of Sniardwy Lake are categorized as Class I (drinkable) during the winter, and Class II (increased pH and total nitrogen) during other seasons. Changes in pH account for the lower classification in spring and summer, while elevated organic nitrogen is responsible for the lower rating in autumn. (Author's abstract)
W90-02757

FIELD SCREENING METHOD FOR GASOLINE CONTAMINATION USING A POLYETHYLENE BAG SAMPLING SYSTEM.
Connecticut Univ., Storrs. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 7B.
W90-02764

RISK-BASED SELECTION OF MONITORING WELLS FOR ASSESSING AGRICULTURAL CHEMICAL CONTAMINATION OF GROUND WATER.
For primary bibliographic entry see Field 7A.
W90-02765

ASSESSING ARKANSAS GROUND WATER FOR PESTICIDES: METHODOLOGY AND FINDINGS.
ENSECO, Inc., Boston, MA.
T. C. Cavalier, T. L. Lavy, and J. D. Mattice.
Ground Water Monitoring Review GWMRDU, Vol. 9, No. 4, p 159-166, 1989. 1 fig, 2 tab, 21 ref.

Descriptors: *Monitoring, *Pollutant identification, *Arkansas, *Pesticides, *Groundwater pollution, Herbicides, Fungicides, Insecticides, Monitoring, Drinking water.

During 1985 to 1987, 119 wells, springs and municipal drinking water supplies throughout Arkansas were monitored for the presence of pesticides. Pesticides selected for analysis included acifluorfen, alachlor, aldicarb, atrazine, benomyl, cyanazine, cypermethrin, 2,4-D, dichlorprop, diuron, fenvalerate, fluometuron, hexazinone, linuron, metolachlor, permethrin, picloram, and propanil. Not every sample was analyzed for ever pesticide. Overall, results indicated that the 18 herbicides, fungicides, and insecticides were not present in the ground water samples studied. (Note: Detectable concentrations of three herbicides--alachlor, atrazine, and metolachlor--were found in one irrigation well, at 5.5, 5.8, and 6.9 micrograms/L, respectively. However, since previous and subsequent sampling failed to detect these compounds, their presence is attributed to a localized spill or handling error rather than agricultural application.) (Author's abstract)
W90-02771

SMALL-SCALE RETROSPECTIVE GROUND WATER MONITORING STUDIES FOR AGRICULTURAL CHEMICALS: STUDY DESIGN AND SITE SELECTION.
Blasland, Bouck and Lee, Syosset, NY.
For primary bibliographic entry see Field 7A.
W90-02772

EPA'S APPROACH TO EVALUATING AND CLEANING UP GROUND WATER CONTAMINATION AT SUPERFUND SITES.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-02773

CHARACTERIZATION OF TOXIGENIC VIBRIOS ISOLATED FROM THE FRESHWATER ENVIRONMENT OF HIROSHIMA, JAPAN.
Hiroshima Univ. (Japan). Dept. of Food Microbiology and Hygiene.
K. Venkateswaran, C. Kiiyukia, M. Takaki, H. Nakano, and H. Matsuda.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 10, p 2613-2618, 1989. 1 fig, 5 tab, 37 ref.

Descriptors: *Bacteria, *Japan, *Pathogenic bacteria, *Toxins, *Vibrio, Clostridium, Cytotoxins, Characterization.

The occurrence and characterization of toxigenic vibrios in surface water and sediment samples of the fresh water environment of the Ohta River were studied. The membrane filter, pad preenrichment technique, followed by the placement of membranes onto thiosulfate citrate-bile salt-sucrose agar, was used for the enumeration of total vibrios. Qualitative examination of pathogenic vibrios was also attempted. In addition, a survey was conducted to determine the incidence of Clostridium botulinum in sediment samples of the Ohta River and the Hiroshima coast. In the identification of 361 strains, 12 species of Vibrio and two species of Listonella were observed. Non-01 Vibrio cholerae was prevalent among the members of the genus Vibrio. Vibrio parahaemolyticus (serotype 04:K34), isolated in fresh water, is significant and suggests that some still unknown conditions promote the survival of these organisms in fresh water. An estimated 132 strains were hemolytic by a simple agar method, and further characterization revealed that 82% of the hemolytic vibrios (107 strains) produced various toxins. About 71% (93 strains) elaborated cytotoxin, 55% (72 strains) produced hemolysin, and 44% (58 strains) responded for both cytotoxin and hemolysin in the crude toxin extracts. All the non-01 V. cholerae showed cytotoxic activity, and the virulent strains of Vibrio fluvialis and Vibrio spp. showed cytotonic responses in RK-13 cells. Of 36 sediment samples tested, 10 harbored C. botulinum spores (28%) and were isolated invariably in all the regions of the Hiroshima coast and in the Ohta River, except the upper region of the Ohta River. (Author's abstract)
W90-02789

SIMPLE METHOD FOR DETERMINATION OF BIODEGRADABLE DISSOLVED ORGANIC CARBON IN WATER.
Universite Libre de Bruxelles (Belgium). Groupe de Microbiologie des Milieux Aquatiques.
For primary bibliographic entry see Field 7B.
W90-02792

DETERMINATION OF SULFONATED AZO DYES IN MUNICIPAL WASTEWATER BY ION SPRAY LIQUID CHROMATOGRAPHY TANDEM MASS SPECTROMETRY.
New York State Coll. of Veterinary Medicine, Ithaca.
P. O. Edlund, E. D. Lee, J. D. Henion, and W. L. Budde.
Biomedical and Environmental Mass Spectrometry BMSYAL, Vol. 18, No. 4, p 233-240, Apr 1989. 5 fig, 4 tab, 18 ref. EPA Cooperative Agreement No. CR 811661-02-0.

Descriptors: *Water analysis, *Chromatography, *Azo dyes, *Dyes, *Ion spray liquid chromatography, *Mass spectrometry, *Pollutant identification, Sulfonated azo dyes, Municipal wastewater.

A liquid-solid extraction method suitable for rapid screening of sulfonated azo dyes in municipal wastewater has been developed. The dyes (Color Index Acid Yellow 23, Red 14 and Yellow 49)

were separated on a short, reversed-phase liquid chromatographic column with a water-methanol gradient containing 2 mM sulfuric acid. The column effluent was directed via a split-valve to an ion spray liquid chromatography/mass spectrometry (LC/MS) interface to an atmospheric pressure ionization mass spectrometer. The ion spray LC/MS system produced abundant (M--Na)(-) and (M--2Na)(2-) ions according to the number of sulfonic acid substituents. Collision-induced dissociation of the parent ions for the dyes studied gave the SO3(-) fragment common to sulfonated compounds plus additional daughter ion fragments characteristic of each dye. The dyes were quantified by monitoring from four to six different daughter ions of each dye. The relative abundances and the sum of the daughter ion current counts were used for confirmation and quantification with external standards. Recoveries of the dyes were in the range of 70-122%, and the relative standard deviation of replicate determinations was 5.4-12%. The method detection limit was three times higher for Acid Yellow 23 compared with the other two dyes, which could be detected down to 50 ppb in municipal wastewater. (Author's abstract)
W90-02812

DETERMINATION OF HERBICIDES AND THEIR DEGRADATION PRODUCTS IN SURFACE WATERS BY GAS CHROMATOGRAPHY/POSITIVE CHEMICAL IONIZATION/TANDEM MASS SPECTROMETRY.
Geological Survey, Denver, CO.
C. E. Rostad, W. E. Pereira, and T. J. Leiker.
Biomedical and Environmental Mass Spectrometry BMSYAL, Vol. 18, No. 9, p 820-827, Sep 1989. 2 fig, 4 tab, 19 ref.

Descriptors: *Herbicides, *Gas chromatography, *Mass spectrometry, *Atrazine, *Water analysis, *Pollutant identification, *Simazine, *Alachlor, Surface water, Detection limits, Degradation products, Chemical ionization.

A rapid, sensitive and specific method was developed for the analysis of selected herbicides and their degradation products in surface water samples using gas chromatography/positive chemical ionization/tandem mass spectrometry (GC/PCI/MS/MS). Compounds included atrazine and its degradation products (deethylatrazine and deisopropylartrazine), simazine, alachlor and its degradation products (2-chloro-2',6'-diethylacetanilide, 2-hydroxy-2',6'-diethlacetanilide and 2,6-diethylaniline) and metolachlor. Daughter ion spectra for the protonated molecule of these compounds were generated and described. The coeluting interferences present using GC/electron impact mass spectrometry in the surface water samples were eliminated by using GC/PCI/MS/MS in the neutral loss mode to detect specific daughter ions. The detection limit for most of the compounds was 200 pg, and instrument response was linear over three orders of magnitude. (Author's abstract)
W90-02813

DETECTION OF LEGIONELLA PNEUMOPHILA IN ENVIRONMENTAL WATER SAMPLES USING A FLUORESCEIN CONJUGATED MONOCLONAL ANTIBODY.
Liverpool Univ. (England). Dept. of Medical Microbiology.
T. Makin, and C. A. Hart.
Epidemiology and Infection EPINEU, Vol. 103, No. 1, p 105-112, Aug 1989. 1 fig, 4 tab, 18 ref.

Descriptors: *Bacteria, *Legionella, *Pollutant identification, *Monoclonal antibodies, Water quality, Testing procedures, Cultures, Comparison studies.

Sixty-three environmental water samples from various sources were examined for the presence of Legionella pneumophila with a commercially available direct fluorescent monoclonal antibody (GS), an indirect fluorescent antibody test (IFAT) and culture. GS detected L. pneumophila in 94% and 100% of environmental water samples which were culture and IFAT positive for L. pneumophila, respectively. IFAT detected 69% of L.

pneumophila culture positive samples. Cultures of L. pneumophila serogroups 1 to 12, 14 and non-L. pneumophila bacteria which may be found in water, and bacteria containing non-specific binding proteins, were stained by GS and IFAT. GS identified all serogroups of L. pneumophila and did not cross react with any non-L. pneumophila bacteria. L. pneumophila in environmental samples was easy to detect against a clear dark background when stained with GS. (Author's abstract)
W90-02814

WATERBORNE OUTBREAK OF CAMPYLOBACTER ENTERITIS AFTER OUTDOORS INFANTRY DRILL IN UTTI, FINLAND.
Valtion Elainlaaketieteellinen Laitos, Helsinki (Finland).
For primary bibliographic entry see Field 5C.
W90-02815

OCCURRENCE OF DRUG-RESISTANT BACTERIA IN COMMUNAL WELL WATER AROUND PORT HARCOURT, NIGERIA.
For primary bibliographic entry see Field 5B.
W90-02816

AUTOMATED METHOD FOR DETERMINING NITRATE AND NITRITE IN WATER AND SOIL EXTRACTS.
Northeastern Forest Experiment Station, Berea, KY.
R. B. Willis, and C. E. Gentry.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 18, No. 6, p 625-236, June 1987. 1 fig, 1 tab, 26 ref.

Descriptors: *Water analysis, *Chemical analysis, *Pollutant identification, *Nitrogen, *Nitrates, *Nitrites, *Soil analysis, *Acid rain, *Colorimetry, Soil solution, Inorganic nitrogen.

An AutoAnalyzer colorimeter method was used for measuring nitrate plus nitrite in thirteen commonly used soil extraction solutions. The AutoAnalyzer is normally equipped with a column containing cadmium chips. The column was replaced with a cadmium-silver wire inserted in plastic tubing which has several advantages. There is no compaction of cadmium chips, it eliminates the need to debubble the sample stream before it enters the reductor, the dead volume is decreased, and it eliminates the copper sulfate treatment process except for one given the first time the wire is used. The method is also excellent for measuring nitrate plus nitrite in rain water. The nitrate content of water or extracting solution can be determined accurately in the range of .01 to 2 mg/L of nitrate nitrogen. Soil extracts or water containing more than 2 mg/L can be accurately diluted with less than 5% error. (Ence-PTT)
W90-02833

PCB CONGENERS TO MONITOR WITH CAGED JUVENILE FISH IN THE UPPER HUDSON RIVER.
New York State Dept. of Environmental Conservation, Albany.
P. A. Jones, R. J. Sloan, and M. P. Brown.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 9, p 793-803, 1989. 4 fig, 5 tab, 35 ref. EPA Grant C361167-01.

Descriptors: *Bioassay, *Fish, *Bioindicators, *Polychlorinated biphenyls, *Hudson River, Bioaccumulation, Organic compounds, Water pollution effects, Dredging, Sediment concentration, Juvenile growth stage.

The Upper Hudson River is massively contaminated with polychlorinated biphenyls (PCBs). Remediation by removing selected contaminated sediment deposits has been proposed. Evaluation of the impact of dredging the contaminated sediment will be necessary. In 1985, this study was undertaken to develop a monitoring tool to document dredging-induced effects on riverine biota. This monitoring study of bioaccumulation identified a distinct pattern of consistently most abundant PCB congeners in caged juvenile fish. An identical qualitative con-

gener pattern was recognized in juvenile fish after 28-d exposures in the late spring, summer and fall, even though each period is characterized by a different temperature and flow regime in the river. The same congener pattern is evident after only 3 d of exposure and persists until at least 42 d. Due to their physicochemical properties, biological half-life in fish and site-specific abundance in the upper Hudson River sediments, 1 tri-CB, 13 tetra-CBs and 3 penta-CBs (3,4,4'; 2,2',3,4'; 2,2',3,5'; 2,2',4,4'; 2,2',4,5; 2,2',4,5'; 2,2',5,5'; 2,3,3',6; 2,3,4,5; 2,3',4,4'; 2,3',4',5; 2,3',5',6; 2,4,4',6; 2',3,4,5; 2,2',3,5,6; 2,2',3,5',6; and 2,2',4,6,6') are the congeners to monitor over the short term. (Author's abstract)
W90-02842

STABILITY OF NITRATE-ION IN SIMULATED DEPOSITION SAMPLES USED FOR QUALITY-ASSURANCE ACTIVITIES BY THE U.S. GEOLOGICAL SURVEY.
Geological Survey, Denver, CO. Water Resources Div.
T. C. Willoughby, R. B. See, and L. J. Schroder.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4042, July 1989. 15p, 6 fig, 8 tab, 6 ref.

Descriptors: *Acid rain, *Water chemistry, *Sample preservation, *Nitrates, *Chemical analysis, *Quality control, Stability analysis.

Three experiments were conducted to determine the stability of nitrate-ion concentrations in simulated deposition samples. In the four experiment-A solutions, nitric acid provided nitrate-ion concentrations ranging from 0.6 to 10.0 mg/L and that had pH values ranging from 3.8 to 5.0. In the five experiment-B solutions, sodium nitrate provided nitrate-ion concentrations ranging from 0.5 to 3.0 mg/L. The pH was adjusted to about 4.5 for each of the solutions by addition of sulfuric acid. In the four experiment-C solutions, nitric acid provided nitrate-ion concentrations ranging from 0.5 to 3.0 mg/L. Major cation and anion concentrations were added to each solution to simulate natural deposition. Aliquots were removed from the 13 original solutions and analyzed by ion chromatography about once a week for 100 days to determine if any changes occurred in nitrate-ion concentrations throughout the study period. No substantial changes were observed in the nitrate-ion concentrations in solutions that had initial concentrations below 4.0 mg/L in experiments A and B, although most of the measured nitrate-ion concentrations for the 100-day study were below the initial concentrations. In experiment C, changes in nitrate-ion concentrations were much more pronounced; the measured nitrate-ion concentrations for the study period were less than the initial concentrations for 62 of the 67 analyses. (USGS)
W90-02858

EVALUATION OF THE EFFECTS OF WELL CONSTRUCTION MATERIALS AND GROUND-WATER SAMPLING EQUIPMENT ON CONCENTRATIONS OF VOLATILE ORGANIC COMPOUNDS.
Battelle Pacific Northwest Labs., Richland, WA.
T. L. Liikala, D. S. Daly, and A. P. Toste.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-014685. Price code: A03 in paper copy, A01 in microfiche. Report No. PNL--6585, August 1988. 25p, 10 fig, 5 tab, 4 ref. DOE Contract DE-AC06-76RL0 1830.

Descriptors: *Well construction, *Groundwater quality, *Samplers, *Pollutant identification, *Hanford site, *Volatile organic compounds, Groundwater pollution, Gas chromatography, Organic compounds, Water sampling.

In 1985, the Pacific Northwest Laboratory conducted a study on groundwater samples collected from the 300 Area of the Hanford Site, which is located in southeastern Washington. The purpose of the study was to evaluate how well construction materials and groundwater sampling equipment affect measured concentrations of volatile organic

compounds in the groundwater. Groundwater samples were collected in an area of known contamination from two monitoring wells. Sampling was conducted for a total of 4 weeks using three dedicated sampling devices. Each sample was analyzed for volatile organic content by gas chromatography with electron capture detection. The data were statistically analyzed to ascertain differences in concentrations of contaminants resulting from well construction materials and groundwater sampling equipment. No statistically significant differences in concentrations of volatile organic compounds were found resulting from the well construction materials and groundwater sampling equipment. Analyses indicate a correlation between constituent concentration and sample data and, to a lesser degree, water table elevation. The range in concentrations during the study was greater than the differences caused by the two wells and three sampling devices. (Author's abstract)
W90-02924

RCRA (RESOURCE CONSERVATION AND RECOVERY ACT) FACILITY INVESTIGATION (RFI) GUIDANCE. VOLUME 3: AIR AND SURFACE WATER RELEASES.
NUS Corp., Gaithersburg, MD.
For primary bibliographic entry see Field 5B.
W90-02936

GROUNDWATER MONITORING NETWORK DESIGN.
Wright State Univ., Dayton, OH. Dept. of Geology.
For primary bibliographic entry see Field 7A.
W90-03090

U.S. ENVIRONMENTAL PROTECTION AGENCY'S STRATEGY FOR GROUND WATER QUALITY MONITORING AT HAZARDOUS WASTE LAND DISPOSAL FACILITIES LOCATED IN KARST TERRANES.
Environmental Protection Agency, Washington, DC. Office of Research and Development.
For primary bibliographic entry see Field 2F.
W90-03162

BASIC HYDROGEOLOGICAL CHARACTERISTICS OF KARST-WATER INFILLED MINERAL DEPOSITS AND THE HAZARD PREVENTION, CONTROL AND UTILIZATION OF KARST WATER IN CHINA.
Zhengding Inst. of Hydrogeology and Engineering Geology (China).
For primary bibliographic entry see Field 2F.
W90-03173

EFFECTS OF FREEZING ON TOXICITY OF SEDIMENTS CONTAMINATED WITH DDT AND ENDRIN.
Corvallis Environmental Research Lab., OR.
For primary bibliographic entry see Field 5C.
W90-03207

VARIABILITY ASSOCIATED WITH IDENTIFICATION OF TOXICS IN NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) EFFLUENT TOXICITY TESTS.
Shell Development Co., Houston, TX.
P. B. Dorn, and J. H. Rodgers.
Environment Toxicology and Chemistry ETOCDK, Vol. 8, No. 10, p 893-902, 1989. 5 fig, 1 tab, 17 ref.

Descriptors: *Pollutant identification, *Water analysis, *Variability, *National Pollutant Discharge Elimination System, *Water quality standards, *Effluents, *Toxicity, *Testing procedures, *Laboratory methods, Calcium, Organic compounds, Daphnia, Fish, Bacteria.

Effluent toxicity testing is a routine National Pollutant Discharge Elimination System (NPDES) permit monitoring requirement for many municipal and industrial dischargers. Effluent toxicity compliance limits are being set in an increasing effort to limit discharge of toxics into U. S. water bodies. To that end, hazard assessment principles are being applied to limit discharged toxicity based on instream effects as judged by effluent toxicity, fate and exposure. Uncertainty arises in complying with effluent toxicity limits because of a number of factors, including an unacceptably toxic effluent, error in conducting a specified test, test organism health, statistical variability and interferences in the test solution that mask the toxic effect. This study examined the results of studies to investigate three factors: test animal health, statistical variability and interferences. The examples presented illustrate (a) the importance of determining animal health by using the reference toxicant test; (b) the statistical variability associated with compliance by two refinery effluents with toxicity limits; and (c) how compounds often considered nontoxic can interfere with toxicity test results for a chemical plant effluent. These factors indicate the need for additional consideration before setting permit limits, determining requirements for toxicity reduction and possibly implementing additional effluent treatment. Comparisons between reference toxicant data and control mortality showed that reference toxicant data provide an additional control for determining whether effluent toxicity test results are valid and that they can be used to test regulatory compliance. Statistical sampling theory was explored to determine compliance with an effluent toxicity requirement of 80% survival in 100% effluent. Third, several test species were used to determine the causative toxic agents in order to correctly identify toxicity and to separate true toxic effects from interferences in exposures to receiving water. (Author's abstract)
W90-03208

EXTRACTION OF BUTYLTIN SPECIES AND THEIR GAS CHROMATOGRAPHIC DETERMINATION AS CHLORIDES IN A SEDIMENT CERTIFIED REFERENCE MATERIAL FOR TRACE METALS, PACS-1.
National Research Council of Canada, Ottawa (Ontario). Div. of Chemistry.
K. W. M. Siu, P. S. Maxwell, and S. S. Berman.
Journal of Chromatography JOCRAM, Vol. 475, p 373-379, Jul 28, 1989. 3 fig, 2 tab, 14 ref.

Descriptors: *Chemical analysis, *Antifoulants, *Pesticides, *Metal organic pesticides, *Organotin compounds, *Separation techniques, *Pollutant identification, *Gas chromatography, *Quantitative analysis, Organic compounds, Tin, Sediments, Heavy metals, Laboratory methods.

Due to their significant environmental impact, the butyltin species are under intense scrutiny. A gas chromatographic method has been developed for the determination of butyltin species in sediments. The butyltin species are separated as chlorides by using a DB-608 open tubular column after their extraction from the sediment using a combination of sonication in methanolic HCl and solvent extraction. Two extractants are possible: toluene-isobutyl acetate-tropolone and hexane-isobutyl acetate. The efficiencies for the first extractant are tributyltin, 94.4 +/-4.7%; dibutyltin, 94.9 +/-2.2%; and monobutyltin, 86.3 +/-4.2%. The absolute detection limits are about 30 pg tin. Using a 1-g sample, the relative detection limits are about 30 ng tin/g sediment. These may be lowered to 3 ng tin/g by starting with a 4-g sample and adding a concentration step. The reference material PACS-1 was found to contain 1.08 +/-0.31 micrograms tin per g of tributyltin and 1.13 +/-0.30 micrograms tin per g of dibutyltin. (Author's abstract)
W90-03227

HIGH BOILING ORGANIC TRACES IN DRINKING WATER: QUANTITATIVE ANALYSIS BY LIQUID-LIQUID ENRICHMENT WITHIN THE ANALYTICAL GLASS CAPILLARY.
Institut fuer Chromatographie, Bad Duerkheim (Germany, F.R.).
R. E. Kaiser, and R. Rieder.
Journal of Chromatography JOCRAM, Vol. 477, N. 1, p 49-52, Aug 23, 1989. 4 fig, 1 ref.

Descriptors: *Pollutant identification, *Water analysis, *Quantitative analysis, *Gas chromatography, *Organic compounds, *Drinking water, Pollutants, Laboratory methods, Water pollution control, Trace levels, Water quality standards.

The latest European regulations about drinking water analysis make it necessary to check for a wide variety of organic key compounds in drinking water in the sub-ppb range. Without primary enrichment, most analytical methods available today are unsuitable for this purpose. There are in addition serious problems of taking, storing and manipulating the sample which may lead to incorrect determinations, and simple technical and human problems when the enrichment step commences with sample volumes greater than or equal to 1 L of water. In this method, the trace organic contaminants are concentrated by liquid-liquid enrichment. A water sample is forced through a 20-m x 0.3 mm I.D. glass capillary coated on the inside with a 0.25 micrometer thick film of PS-089 (94-96% dimethyl-/4-6% diphenylsiloxane) at room temperature with nitrogen gas. The organic traces were flushed back into a 10 to 30 mm section at the inlet of the glass capillary by heating all but that section of the capillary in a gas chromatographic oven while applying a low carrier gas pressure at the detector end of the capillary. The oven was heated at 30 degrees C/min to 320 degrees C. After the oven was allowed to cool, a carrier gas was applied at the inlet and the inlet region was heated. The organic traces were carried through the capillary as if they were sampled on-line. In the resulting gas chromatogram, there was no solvent effect nor retention gap effect. There was no split nor any specific loss besides that which occurred during the storage of the sample. Temperature programmed GC was carried out and the chromatogram was quantitated. (Ence-PTT)
W90-03228

DETERMINATION OF MERCURY IN NATURAL SAMPLES AT THE SUB-NANOGRAM LEVEL USING INDUCTIVELY COUPLED PLASMA/MASS SPECTROMETRY AFTER REDUCTION TO ELEMENTAL MERCURY.
Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Analytical and Marine Chemistry.
C. Haraldsson, S. Westerlund, and P. Oehman.
Analytica Chimica Acta ACACAM, Vol. 221, No. 1, p 77-84, June 1989. 2 fig, 14 ref.

Descriptors: *Mercury, *Trace levels, *Chemical analysis, *Pollutant identification, *Mass spectrometry, Sediments, Natural waters, Separation techniques, Trace elements, Detection limits, Precision.

Inductively coupled plasma/mass spectrometry was used to determine mercury in natural waters and sediments. This approach minimizes sample handling and thereby reduces the problem of contamination. The use of a mass spectrometer as a detector makes it possible to use the isotope dilution method for sample preparation. Sodium borohydride was used to reduce the mercury to its elemental form, which was purged directly to the plasma using the nebulizer gas. The detection limit, defined as three times the standard deviation of the blank, is 8 picograms. The precision at the 100-picogram level is 3%. (Geiger-PTT)
W90-03231

DETERMINATION OF NITRATE IN NATURAL WATERS BY VOLTAMMETRY AT A STATIONARY MERCURY DROP ELECTRODE.
Univerzita Pavla Jozefa Safarika, Kosice (Czechoslovakia). Dept. of Physical and Analytical Chemistry.
K. Murkusova.
Analytica Chimica Acta ACACAM, Vol. 221, No. 1, p 131-138, June 1989. 4 fig, 1 tab, 17 ref.

Descriptors: *Water analysis, *Nitrates, *Voltammetry, *Pollutant identification, *Electrodes, Humic substances, Natural waters, Cations, Drinking water, Fulvic acids.

Nitrate can be determined by second-sweep cyclic voltammetry at a stationary mercury drop electrode utilizing the autocatalytic effect of the hy-

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droxyl ions formed at the surface of the electrode during the reduction of nitrate in the presence of an excess of trivalent cations. The reduction current in the second sweep with the same drop is proportional to the nitrate concentration in the range of 1-1,500 micromoles/liter in natural waters. The humic substances present in natural waters have a favorable effect on the determination of nitrate. The method is applied to the determination of nitrate in drinking and river waters. (Author's abstract)
W90-03232

DETERMINATION OF METHYLMERCURY IN NATURAL WATERS AT THE SUB-NANO-GRAMS PER LITER LEVEL BY CAPILLARY GAS CHROMATOGRAPHY AFTER ADSORB-ENT PRECONCENTRATION.
Swedish Environmental Research Inst., Goeteborg.
Y. H. Lee, and J. Mowrer.
Analytica Chimica Acta ACACAM, Vol. 221, No. 2, p 259-268, June 1989. 4 fig, 3 tab, 24 ref.

Descriptors: *Trace levels, *Water analysis, *Mercury, *Methylmercury, *Pollutant identification, *Gas chromatography, Separation techniques, Natural waters, Humic acids.

Methylmercury was preconcentrated from water on to a sulf-hydryl cotton fiber adsorbent, using the column technique or the batch-column two-stage technique. A small volume of 2 M HCl was used to elute methylmercury and to separate it from inorganic mercury; 0.4-0.6 ml of benzene was used to extract methylmercury from the eluate. Analysis was performed by capillary gas chromatography with electron-capture detection. The detection limit for methylmercury was < 0.05 nanograms/liter in a 4-liter water sample. Four surface waters were analyzed to test the agreement of methylmercury concentration between the two preconcentration methods, and to test the interference of humic substances on the filtered and unfiltered surface water. The methylmercury concentrations found in different surface water samples ranged from 0.08 to 0.48 nanograms/liter. (Author's abstract)
W90-03233

USE OF OYSTER SHELL THICKNESS AND CONDITION INDEX MEASUREMENTS AS PHYSIOLOGICAL INDICATORS OF NO HEAVY METAL POLLUTION AROUND THREE COASTAL MARINAS.
South Carolina State Dept. of Health and Environmental Control, State Park.
J. M. Marcus, G. I. Scott, and D. D. Heizer.
Journal of Shellfish Research JSHRDA, Vol. 8, No. 1, p 87-94, June 1989. 3 fig, 6 tab, 34 ref.

Descriptors: *Water quality monitoring, *Bioindicators, *Marinas, *Oysters, *Bioindicators, *Heavy metals, Water pollution effects, Bioaccumulation, Monitoring, South Carolina, Shellfish, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Zinc.

Oysters were collected from areas near three recreational marinas in southern coastal South Carolina on Hilton Head and Fripp Islands and were analyzed for shell content of heavy metals (cadmium, chromium, copper, lead, mercury, nickel, and zinc). There were no significant differences in shell thickness and between indigenous populations of oysters (Crassostrea virginica) at three recreational marinas in coastal South Carolina or between other estuarine areas of the State. Soft tissue concentrations of heavy metals from the study areas were not elevated relative either to marina proximity or to ambient background monitoring stations. Condition index analyses demonstrated no physiological stress on the oysters. The lack of significant changes in shell thickness and condition index, along with the absence of significantly increased metal levels in tissues and in sediments supports the observation that heavy metals do not appear to be a major pollutant around recreational marinas in coastal South Carolina. (Author's abstract)
W90-03262

ORGANIC MERCURY SPECIATION IN FISH BY CAPILLARY GAS CHROMATOGRAPHY INTERFACED WITH ATOMIC ABSORPTION SPECTROMETRY.
Academia Sinica, Beijing (China). Research Center for Eco-Environmental Sciences.
J. Gui-bin, N. Zhe-ming, W. Shun-rong, and H. Heng-bin.
Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 334, No. 1, p 27-30, May 1989. 4 fig, 1 tab, 16 ref.

Descriptors: *Pollutant identification, *Chemical speciation, *Mercury, *Methylmercury, *Fish, *Gas chromatography, *Atomic absorption spectrophotometry, Organomercurials, Tissue analysis, Detection limits, Animal tissues, Separation techniques, Biological samples.

A rapid method for the speciation of mercury in fish is described. Organomercurials in benzene extract are separated by glass capillary gas chromatography and detected by atomic absorption spectrometry. Spiked alkylmercury in fish yielded 95% recovery with one single extraction with benzene. The absolute detection limit was about .0001 microgram mercury. The method can be applied to the determination of 0.04 ppm of mercury in a 0.5 g sample. The method described can be used not only for the simultaneous determination of diethylmercury, methylmercury, ethylmercury and phenylmercury in fish, but should be useful also for other biological samples. (Geiger-PTT)
W90-03270

COMPARATIVE EVALUATION OF RESIDUAL AND TOTAL METAL ANALYSES IN POLLUTED SOILS.
Pennsylvania State Univ., University Park. Dept. of Agricultural Engineering.
H. A. Elliott, and G. A. Shields.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 19, No. 16, p 1907-1915, Dec 1988. 3 tab, 18 ref.

Descriptors: *Soil contamination, *Pollutant identification, *Heavy metals, *Chemical analysis, *Sludge digestion, Lead, Cadmium, Zinc, Copper, Comparison studies, Acids.

Two digestion procedures, employing aqua regia-HF and HNO3-HClO4-HF, were used to analyze residual metals (following a chemical fractionation scheme) and total metal content of two soils, one moderately polluted by municipal sludge applications and the other a grossly-contaminated sample (20.8% Pb) from a battery recycling site. Although commonly used in sequential extraction analyses, the aqua regia-HF method solubilized only 53% of the HNO3-HClO4-HF determined residual Pb in the battery soil. For the sludge-amended soil, residual Cd, Pb, and Zn were not statistically different by the two methods. For the battery soil, a single aqua regia-HF extraction also underestimated total Pb and Cu relative to HNO3-HClO4-HF, but both methods gave statistically-similar total Cd, Cu, Pb, and Zn for the sludge-amended soil. As the sample metal concentration increased, the ability of aqua regia-HF to solubilize HNO3-HClO4-HF-equivalent metal quantities generally decreased. Since the degree of contamination is often unknown for environmental samples, the HNO3-HClO4-HF method is more reliable for assessing residual and total metals in polluted soils. (Author's abstract)
W90-03299

DETERMINATION AND DISTRIBUTION OF HYDROXYLATED AROMATIC COMPOUNDS IN ESTUARINE WATERS.
Cochin Univ. of Science and Technology (India). Div. of Chemical Oceanography.
S. M. Nair, A. N. Balchand, and P. N. K. Nambisan.
Toxicological and Environmental Chemistry TXECBP, Vol. 22, No. 1-4, p 203-213, 1989. 7 fig, 4 tab, 25 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Chemical analysis, *Aromatic compounds, *Estuaries, *Coastal waters, *Marine sediments, *Pulp and paper industry, Effluents, Organic compounds, Spectrophotometry, Water pollution.

Lignins, tannins and other derivatives are found abundantly in pulp-paper mill effluents as well as in natural streams receiving run off from forestry areas. A modified methodology has been developed to determine quantitatively the content of lignins and tannins in the aquatic environment by detecting hydroxylated aromatic groups in the hydroxylated aromatic compounds in aquatic waters and sediments. Interference in seawater samples was overcome by addition of citrate solution permitting the blue color development on reduction of phosphotungstic and phosphomolybdic acids by the aromatic hydroxylated groups present in lignins and tannins. The above procedure was adopted to study the fate of tannin and lignin-like substances (TALLS) in tropical estuarine and coastal waters and sediments receiving pulp-paper effluents. (Ence-PTT)
W90-03349

SPECIATION OF PARTICULATE TRACE METALS IN SEDIMENTS OF ANARBE RESERVOIR.
Universidad del Pais Vasco, San Sebastian (Spain). Dept. de Quimica Aplicada.
I. Larumbe, and A. Casado.
Toxicological and Environmental Chemistry TXECBP, Vol. 23, No. 1-4, p 135-141, 1989. 4 fig, 2 tab, 7 ref.

Descriptors: *Path of pollutants, *Reservoirs, *Chemical speciation, *Heavy metals, *Trace metals, *Sediments, *Drinking water, Iron, Manganese, Nickel, Cadmium, Zinc, Lead, Chromium, Copper, Organic matter, Atomic absorption spectroscopy, Chemical analysis, Spain.

Total concentration and chemical forms of heavy metals in samples of sediment from a drinking water reservoir have been analyzed. The results of total metal content show an Fe and Mn concentration increase along the reservoir, from 4.4% in Fe and 0.07% in Mn in the end part to 6.4% Fe and 0.22% Mn at the dam. However, a decrease in organic matter along the reservoir is observed. In order to test the accuracy of the digestion methods used, a standard reference material was also analyzed. Sequential extractions were used to furnish information about the origin, mode of occurrence, biological and physicochemical availability, mobilization, and transport of the trace metals. Five fractions were obtained: exchangeable, easily reducible phase, moderately reducible phase, organic fraction, and residual fraction. Trace metal concentrations, with exception of Cd, Pb, and Mn, found in fraction 5 are higher than those observed in the other extractions. Fe, Ni, Zn, Cr and Cu content not found in the residual fraction is found mainly in moderately reducible fraction, but the percentage of this fraction in each metal is very different. Lower levels of Fe and Mn with the increase of organic matter suggest a partial redissolution of reducible fractions, and a slow kinetics of the metal-sulfide precipitation, the formation of sulfides complexes, or the formation of organometallic complexes. This explains the presence of high turbidity, besides Fe and Mn contents in water after the turnover. The water quality of the reservoir will be affected by the stratification process, mostly owing to the Fe and Mn dissolved, but no release of other toxic metals can be expected. (Ence-PTT)
W90-03351

HEAVY METAL ANALYSIS IN FISH-KILL CASES IN RIVERS IN GUIPUZCOA (SPAIN).
Universidad del Pais Vasco, San Sebastian (Spain). Lab. Contaminacion.
For primary bibliographic entry see Field 5C.
W90-03352

MONITORING OF HARMFUL SUBSTANCES IN RUNNING WATER BY MEANS OF BEHAVIOR PARAMETERS IN CONTINUOUSLY SWIMMING FISH.
Universitaet des Saarlandes, Saarbruecken (Germany, F.R.). Zoologisches Inst.
C. Kress, and W. Nachtigall.
Zeitschrift fuer Wasser - und Abwasser Forschung

Descriptors: *Bioindicators, *Fish, *Fish behavior, *Phenols, *Monitoring, *Toxicity, Swimming, Running waters, Photography, Trout.

Rainbow trout (Salmo gairdneri) and their specific reactions to clean tap water and to contaminated (5 mg/l phenol) water were studied in a water canal under laminar flow conditions. Their behavior was registered photographically with one frame per three seconds. Analyses were made according to 6 behavior parameters which were divided into 3 to 5 classes. Frequency histograms were made of these classes, their order in time, and the filming of changes in behavior. Thus it was possible to differentiate between the phenol and control tests. Iteration and G-tests were made with grouped data for mutual independence of behavior sequences. After disposing of the non-significant behavioral parameters, significant differences between the two parameters 'position of the longitudinal axis of the body within the test area between in-flowing and out-flowing water', and 'type of movement of the tail fin, either quiet or frantic' remained. Thus it was possible to define the trout's behavior qualitatively as follows: Phenol experiment: The trout swims with frantic movements against the current and close to the bottom of the front part of the test area. Its mouth is slightly open and its body more or less horizontal. Control experiment: The trout swims quietly against the current near the bottom of the front part of the test area. Its mouth is slightly open and its body more or less horizontal. No significant differences between phenol and control tests could be determined by the remaining 4 structural elements. Although certain tendencies became apparent, they could not be defined due to the limited capacity of this preliminary experiment. Furthermore, they are not necessarily required to determine a behavioral biological difference between clean and phenol-contaminated water. To develop further the potential of this biomonitor, the imprint of a trout on a photosensory xy-matrix should be checked every 5 to 10 seconds by computer and compared to the memorized normal behavior (control test). Should any differences be registered, an alarm could be switched on. (Author's abstract)
W90-03353

AUTOMATED EARLY WARNING SYSTEM FOR CONTINUOUS WATER CONTROL WITH TUBIFICIDAE AS TOXICANT INDICATORS.

Descriptors: *Tubificids, *Warning systems, *Monitoring, *Bioindicators, *Water quality control, Toxicity, Pollutants, Videotape, Computers.

The procedure and equipment to perform a motility test with tubificidae as toxicant indicators are described. Test criterion is the change of motility of the experimental animals when their well-being is impaired by deterioration of water quality. The spontaneous activity of the tubificidae is recorded by means of modern video technique and the measured values are continuously rated by a PC-computer (on-line-coupling). If the animals' activity changes significantly as against the norm, the computer gives off alarm and steering signals. The automated test can be used as a self-active early warning system in continuous, biological control of waters and likewise for standardized investigations of noxious effects of chemical substances. (Author's abstract)
W90-03356

DETERMINATION OF TRIAZINE HERBICIDES IN WATER SAMPLES BY SOLID PHASE EXTRACTION AND HIGH PERFORMANCE LIQUID CHROMATOGRAPHY.

Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).
M. Stahl, M. Luhrmann, H. Kicinski, and A.

Descriptors: *Drinking water, *Groundwater, *Herbicides, *Chromatography, *Water analysis, *Pollutant identification, *Triazine herbicides, Organic compounds, Water analysis, Chemical analysis, Spectrophotometry, Quantitative analysis.

An analytical method is described for the determination of 7 triazine herbicides in drinking water and groundwater. The separation of simazine, atrazine, prometone, propazine, ametryne, prometryne, and terbutryn was achieved by High Performance Liquid Chromatography (HPLC) using a LiChrospher RP 18/5 micrometer column and an isocratic mobile phase containing acetonitrile/KH_2PO_4-buffer. The detection is achieved by a UV-detector at 230 nm. As the factor of enrichment is 2000, a detection limit of less than 10 ng/L for any herbicide can be obtained. The recoveries varied between 81% and 129%. (Author's abstract)
W90-03357

DETERMINATION OF DISSOLVED OXYGEN BY PHASE-BOUNDARY-TRANSMISSION--A POSSIBILITY TO ELIMINATE INTERFERENCES CAUSED BY SUBSTANCES IN WATER.

Technische Univ. Berlin (Germany, F.R.). Inst. fuer Technischen Umweltschutz.

For primary bibliographic entry see Field 7B.
W90-03358

ADVANCES IN DETERMINATION OF CATION-ACTIVE AND ANION-ACTIVE SURFACTANTS (LAS) IN SEDIMENTS, SUSPENDED MATTER AND SLUDGES.

Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).
H. Hellmann.

Descriptors: *Pollutant identification, *Water analysis, *Sediments, *Suspended solids, *Sludge, *Surfactants, *Linear alkyl sulfonates, *Alkylbenzene sulfonates, *Chemical analysis, Cations, Quantitative analysis, Photometry, Spectroscopy.

Taking the known photometric determination methods as well as the recently published sample treatment method for aluminum oxide as a basis, in relation to linear alkylbenzene sulfonates (LAS) several variants for the ultraviolet and visible range are presented. With the aid of derivative spectroscopy the determination limit of 1 microgram/ 10 ml solution is reached or even exceeded. In an analogous way, the determination of cation-active surfactants such as distearyldimethylammonium chloride (DSDMAC) could be refined, partly by using a new photometric method and partly through derivative spectroscopy. Derivatives were prepared with sulphan blue, methylene blue, and a modified Dragendorff reagent. Here is the determination limit of 1 microgram/10 ml was also attained. By applying these techniques both sewage sludges with high pollution load (> or = 1000 mg/kg) and slightly contaminated sediments (< 100 mg/kg) can be perfectly analyzed. (Author's abstract)
W90-03359

SURVIVAL AND ACTIVITY OF STREPTOCOCCUS FAECALIS AND ESCHERICHIA COLI IN TROPICAL FRESHWATER.

Puerto Rico Univ., Rio Piedras. Dept. of Biology.
I. Muniz, L. Jimeniz, G. A. Toranzos, and T. C. Hazen.

Descriptors: *Bacterial analysis, *Feces, *Tropical regions, *Rain forests, *Bioindicators, Streptococcus, Escherichia coli, Radiography, Respiration, Coulter counters.

The survival of Streptococcus faecalis and Escherichia coli was studied in situ in a tropical rain forest watershed using membrane diffusion chambers. Densities were determined by acridine orange direct count and Coulter Counter. Population activity was determined by microautoradiography, cell respiration, and by nucleic acid composition. Densities of S. faecalis and E. coli decreased less than 1 log unit after 105 hours as measured by direct count methods. Activity as measured by respiration, acridine orange activity, and microautoradiography indicated that both bacteria remained moderately active during the entire study. After 12 hours, E. coli was more active than S. faecalis as measured by nucleic acid composition. In this tropical rain forest watershed, E. coli and S. faecalis survived and remained active for more than 5 days; consequently, both would seem to be unsuitable as indicators of recent fecal contamination in tropical waters. (Author's abstract)
W90-03371

TRACE ENRICHMENT AND HPLC ANALYSIS OF POLYCYLIC AROMATIC HYDROCARBONS IN ENVIRONMENTAL SAMPLES, USING SOLID PHASE EXTRACTION IN CONNECTION WITH UV/VIS DIODE-ARRAY AND FLUORESCENCE DETECTION.

Gesamthochschule Paderborn (Germany, F.R.). Dept. of Applied Chemistry.
H. G. Kicinski, S. Adamek, and A. Kettrup.

Descriptors: *Hydrocarbons, *Chromatography, *Pollutant identification, *Water analysis, *Chemical analysis, Trace levels, Laboratory equipment, Groundwater pollution, Detection limits.

Both the separation of polycyclic aromatic hydrocarbons (PAH's) on tailor-made high-performance liquid chromatography (HPLC) phases, and their chromatographic enrichment and quantitative determination are of great interest. Since both the concentrations of PAH's in the environment and the limiting values in German legislation for drinking water are relatively low, methods for selective enrichment and sensitive detection are indispensable. Because of their relatively high amounts in soil, determination of PAH's is valuable for assessment of the potential danger to ground water of waste materials. These requirements can be fulfilled by use of solid phase extraction on enrichment columns, and fluorescence or UV/VIS (ultraviolet/visible) diode array detection. For the detection of PAH's in the picogram range, the wavelengths for excitation and emission were programmed over the chromatogram. With this feature, it was possible to detect all the individual compounds at the highest sensitivity, over the entire analysis. The enrichment of PAH's from drinking water and soil samples by solid-phase extraction reduced the time requirements in half in comparison with typical liquid-liquid extraction. The advantages not only include speed but also a large reduction in the volume of solvents required and the selectivity of the extraction using a variety of solid-phase extraction packings. For preconcentration of PAH's from water samples, best results were obtained by application of a C18/NH2 combination, whereas the enrichment of PAH'S from soil samples were best carried out with Si/CN or C18/CN combinations. (Author's abstract)
W90-03433

COMPARISON BETWEEN TWO MICROTOX TEST PROCEDURES.

National Swedish Environment Protection Board, Nykoeping. Brackish Water Toxicology Lab.
M. Tarkpea, and M. Hansson.

Descriptors: *Bioassay, *Marine bacteria, *Effluents, *Monitoring, *Pollutant identification, *Toxicity, Bioluminescence, Comparison studies, Municipal wastewater, Bioindicators, Statistical analysis.

A comparison was made between the two Microtox test procedures, the standard test and the 100% test. In the standard Microtox bioassay, effluents can be tested up to a concentration of 45%. The 100% test method, however, had been developed for screening effluents with an EC50 value > 45%. The relationship between 5-min EC50 values according to the two methods has been studied with a two-way ANOVA analysis for 14 effluents or process waters and one unpurified municipal wastewater sample. All samples were tested twice within a 3-month interval. An F ratio of 15.46 (n = 56) showed that the test methods differed significantly at the 0.1% level. Nevertheless none of the samples had a drastically different EC50 value when tested by the two methods. Both the treatment of bacteria and calculation of the EC50 values, which also affect the width of the 95% fiducial limits, differ in the two procedures. The confidence intervals were found to be 10.4 times broader in the 100% tests than in the corresponding standard test. Although the methods differ from each other both in performance and in statistical comparison of the results, both of them could be useful as rescreening methods for determining toxicity to aquatic organisms. (Author's abstract)
W90-03440

ISOLATION AND RECOVERY OF ORGANO-PHOSPHORUS PESTICIDES FROM WATER BY SOLID-PHASE EXTRACTION WITH DUAL WIDE-BORE CAPILLARY GAS CHROMATOGRAPHY.

Nanco Labs., Wappingers Falls, NY.
P. R. Loconto, and A. K. Gaind.
Journal of Chromatographic Science JCHSBZ, Vol. 27, No. 10, p 569-573, October 1989. 3 fig, 4 tab, 15 ref. EPA Small Business Innovation Research Program, Contract 68-02-4481.

Descriptors: *Water analysis, *Organophosphorus pesticides, *Pollutant identification, *Gas chromatography, *Chemical analysis, Laboratory equipment, Water pollution, Silica, Trace levels.

Organophosphorus pesticides continue to be widely used, necessitating more efficient, cost effective methods to isolate, recover, and quantitate this class of organic compounds from environmental matrices. A systematic study that compares the recoveries of selected organophosphorus pesticides from spiked deionized water using octyl and octadecyl bonded silica sorbents (solid phase extraction, SPE) is reported. A packed column gas chromatography is converted to accept a dual wide-bore capillary configuration with chemically dissimilar liquid phases. One column leads to a thermionic detector while the other column leads to a flame photometric detector. The experimental design affords replicate injections and replicate extraction recovery data. Relative standard deviations are calculated that take into account propagation of error for the replicate injections on each of the SPEs performed. The polarity of the dialkyl phosphate ester moiety is correlated with the SPE extraction efficiency. SPE technique affords ease of manipulation and rapid isolation of analytes of interest when applied in a systematic manner. The experimental approach used enabled a valid conclusion to be drawn concerning the partitioning from water into two similar yet somewhat different chemically bonded silicas. The results provide a basis from which others can proceed with the trace analysis of environmental samples from organophosphorus pesticides using SPE with dual wide-bore capillary gas chromatography. (Author's abstract)
W90-03443

SURFACE-SEDIMENT CHRYSOPHYTES FROM 35 QUEBEC LAKES AND THEIR USEFULNESS IN RECONSTRUCTING LAKEWATER PH.

Queen's Univ., Kingston (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-03458

FINDINGS OF TRIBUTYLTIN, DIBUTYLTIN AND MONOBUTYLTIN IN BIVALVES FROM SELECTED U.S. COASTAL WATERS.

Battelle Ocean Sciences, Duxbury, MA.
For primary bibliographic entry see Field 5B.
W90-03459

EXPERIMENTS EVALUATIONS OF THE MYSID HOLMESIMYSIS COSTATA AS A TEST ORGANISM FOR EFFLUENT TOXICITY TESTING.

California State Dept. of Fish and Game, Monterey. Marine Pollution Studies Lab.
M. Martin, J. W. Hunt, B. S. Anderson, S. L. Turpen, and F. H. Palmer.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 11, p 1003-1012, 1989. 7 fig, 2 tab, 34 ref. California State Water Resources Control Board Contract Nos. 5-222-250-0 and 7-120-250-0.

Descriptors: *Toxicity, *Bioindicators, *Crustaceans, *Bioassay, Zinc, Wastewater.

Laboratory experiments were conducted to evaluate the mysid crustacean Holmesimysis costata as a test organism for routine complex effluent toxicity testing. Three-day-old juvenile mysids, hatched in the laboratory from field-collected gravid females, were used in repetitive 48-h and 96-h mortality tests. With zinc sulfate as a reference toxicant, mean 96-h LC50 and no observed effect concentration (NOEC) values for Holmesimysis were 97 and 56 micrograms/L, respectively, lower than previously reported values for other crustacea. Different laboratories conducting the 96-h mortality test with Holmesimysis produced significantly different results in one trial, but results from different laboratories were not significant different in the second trial. Coefficients of variation between laboratories for LC50s and NOECs were 24 and 33%, respectively, in the first trial, and 25 and 1%, respectively, in the second trial. Juvenile mysids aged 3,5,7 and 9 d old responded similarly to zinc exposure, though control mortality differed among these groups. Gravid female mysids were less sensitive, and 1-d-old mysids had high control mortality; neither group was suitable for toxicity testing. The NOEC for zinc effects on growth was 18 micrograms/L in a 7-d experiment. LC50 and NOEC values for copper were 27 and < 11 micrograms/L (the lowest concentration tested), respectively. Effluents from four municipal sewage treatment plants (primary through secondary) produced LC50s ranging from 4.5 to 64.0% effluent, and NOECs ranging from 1.0 to 32% effluent, depending on the eye of the effluent treatment. (Author's abstract)
W90-03462

GLUTATHIONE-DEPENDENT METABOLISM IN FISH AND RODENTS.

Minnesota Univ.-Duluth. Dept. of Pharmacology.
For primary bibliographic entry see Field 5C.
W90-03466

EVALUATION OF THE FATHEAD MINNOW SEVEN-DAY SUBCHRONIC TEST FOR ESTIMATING CHRONIC TOXICITY.

Environmental Research Lab., Duluth, MN.
T. J. Norberg-King.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 11, p 1075-1089, 1989. 6 fig, 3 tab, 48 ref.

Descriptors: *Bioindicators, *Water pollution effects, *Toxicity, *Fathead minnows, *Heavy metals, *Pesticides, Zinc, Chromium, Diazinon, Carbaryl, Selenium, Silver.

Renewal and flow-through subchronic tests were conducted on fathead minnows (Pimephales promelas) with nine chemicals and the results compared to early life stages (ELS) or life cycle toxicity values for on water type. In addition, ELS tests were conducted simultaneously with four chemicals to compare 7-d and 32-d test values. Reproducibility of the 7-d test was high. The no observable effect concentrations (NOECs) and lowest observed effect concentrations (LOECs) of the 7-d tests agreed with those of the life cycle test for 60% of the chemicals tests, similar to the agreement of the ELS tests to the life cycle tests for the same chemicals. ELS and 7-d NOECs and LOECs for seven of the nine chemicals agreed within a factor of two. For four chemicals, embryos exposed before the 7-d renewal test did not show greater sensitivity than unexposed embryos; with carbaryl, exposed embryos were less sensitive than the unexposed fish. Renewal and flow-through tests agreed well. Growth was the most sensitive parameter for 59% of the tests and survival was the most sensitive for only 11%. (Author's abstract)
W90-03468

DETECTING VIRUSES IN WATER.

Environmental Protection Agency, Cincinnati, OH.
C. J. Hurst, W. H. Benton, and R. E. Stetler.
Journal of the American Water Works Association JAWWA5, Vol. 81, No. 9, p 71-80, September 1989. 1 fig, 7 tab, 127 ref.

Descriptors: *Viruses, *Assay, *Drinking water, *Reviews, *Pollutant identification.

This review on the subject of detecting viruses in water encompasses two topics: (1) methods used for concentrating viruses from large volumes of water to more manageable volumes, and; (2) assay methods used for examining viruses contained in the concentrated samples. Of the 5 most common methods, passive adsorption, direct adsorption, ultrafiltration, direct physicochemical flocculation and phase separation, and affinity chromatography, viruses are most suitably concentrated by directed absorption onto the surface of either a filter material or granular solid. Recovery from the surface is achieved during an elution treatment the reverses the adsorption process thus resulting in a smaller volume of eluant fluid, which may be further processed by a secondary concentration technique. The choice of selecting a technique for quantitating recovered viruses often involves balancing the relative merits of detection sensitivity versus the time required for assay completion. This review presents information on actual target materials detected by various assay techniques and information on evaluating whether a particular type of assay procedure provides a direct measure of viral infectivity. Variations on the nucleic acid hybridization assay may represent the optimum balance for viral assay techniques by simultaneously combining sensitivity, determination of viral infectivity, and rapidity with which the assay can be completed. (Author's abstract)
W90-03471

OPTIMIZED GEL PERMEATION CHROMATOGRAPHIC CLEANUP FOR SOIL, SEDIMENT, WASTES, AND OILY EXTRACTS FOR DETERMINATION OF SEMIVOLATILE ORGANIC POLLUTANTS AND PCBS.

Battelle Columbus Div., OH.
J. M. Czuczwa, and A. Aalford-Stevens.
Journal - Association of Official Analytical Chemists JANCA2, Vol. 72, No. 5, p 752-759, September 1989. 2 fig, 3 tab, 13 ref.

Descriptors: *Chromatography, *Organic compounds, *Pollutant identification, *Pesticides, Sample preparation, Soils, Oil wastes, Hydrocarbons, Polychlorinated biphenyls, Chemical analysis.

A gel permeation chromatographic (GPC) method, used by the U.S. Environmental Protection Agency (USEPA), was modified for cleanup of soil, sediments, wastes, and oily wastes before determination of semivolatile organic pollutants. The modifications included new calibration procedures and control of the amount of material processed. The modifications were evaluated for soil and sediment matrixes in a 5-laboratory study where each laboratory processed a solution containing a phthalate, substituted phenols and benzenes, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), nitroaniline, and pesticides. With the exception of nitroaniline, analyte recoveries were 87-112%, with relative standard deviations (RSDs) of 6.7-26%. Soil samples containing PCBs and fortified with 6 pesti-

cides at 0.7-4 microg/g were also analyzed by the 5 laboratories. The mean recovery of the 6 pesticides was 100% with a mean RSD of 16%. Mean RSD for the determination of total PCBs was 8.9%. An additional modification for the processing of wastes and high concentration waste samples was attempted; this involved GPC processing of sample extracts dissolved in 1 + 1 butyl chloride-methylene chloride. This modification did not improve recoveries of the semivolatile analytes. Finally, the modified GPC protocol was applied to PCB-contaminated reclaimed waste oils samples. Two GPC cleanup steps were used to separate PCBs from the waste oil samples before PCBs were determined by gas chromatography combined with electron-capture detection (GC/ECD). (Author's abstract)
W90-03476

ONE-STEP SAMPLE PREPARATION TECHNIQUE FOR BROAD SPECTRUM GAS CHROMATOGRAPHIC/MASS SPECTROMETRIC DETERMINATION OF ORGANIC PRIORITY POLLUTANTS IN WATER.
Ontario Ministry of the Environment, Rexdale. Trace Organic Section.
A. Alfieri, G. Crawford, and I. Ahmad.
Journal - Association of Official Analytical Chemists JANCA2, Vol. 72, No. 5, p 760-765, September 1989. 2 fig, 4 tab, 20 ref.

Descriptors: *Water analysis, *Chemical analysis, *Pollutant identification, *Gas chromatography, *Mass spectrometry, *Organic compounds, *Phenols, Chemical analysis, Sample preparation.

A rapid and cost-effectiveness sample preparation technique was derived for the qualitative and quantitative determination of a broad spectrum of organic contaminants in water. The technique involves simultaneous in-situ acetylation of phenols with acetic anhydride and one-step extraction of phenol acetates and basic and neutral organic compounds from water. The extract is concentrated and analyzed by gas chromatography/mass spectrometry. The method is rapid and cost-effective. The chromatography and sensitivities of the acetylated phenols vs underivatized phenols are enhanced as a result of considerable reduction in peak tailing and improvement in peak symmetry/integration. The acuracy and precision of the measurements are enhanced compared to previous methods. (Author's abstract)
W90-03477

LIQUID CHROMATOGRAPHIC DETERMINATION OF TOTAL FORMALDEHYDE IN DRINKING WATER.
Oak Ridge National Lab., TN. Health and Safety Research Div.
B. A. Tomkins, J. M. McMahon, and W. M. Caldwell.
Journal - Association of Official Analytical Chemists JANCA2, Vol. 72, No. 5, p 835-839, September 1989. 3 fig, 1 tab, 11 ref.

Descriptors: *Water analysis, *Chemical analysis, *Formaldehyde, *Drinking water, *Pollutant identification, Detection limits, Temperature.

Formaldehyde is readily quantitated at microg/L levels in drinking water. The analyte present in 1 L water samples is derivatized with 2,4-dinitrophenylhydrazine in a 2M acid medium and then extracted with chloroform. After the solvent is exchanged for methanol, the product is separated and quantitated using reverse-phase liquid chromatography with UV detection (365 nm). Reporting limits as low as 20 microg/L (corrected for laboratory blank) are routinely achieved. Formaldehyde recovery typically exceeds 90% at 20-200 microg/L. The method was applied to hot and cold water samples from thirty-four 1-story and 2-story houses equipped with poly(acetal) plumbing elbows and tees. The drinking water samples were accompanied by sets of blanks and spikes specified by a quality assurance/quality control plan. Formaldehyde was observed above the reporting limit in 80% of hot and cold water samples from the 1-story dwellings, but in less than 50% of those from the 2-story dwellings. The results may depend on

both the construction of the houses (1-story vs 2-story) and the time of year the water is sampled (mid-summer). (Author's abstract)
W90-03478

CAPILLARY COLUMN GAS CHROMATOGRAPHIC DETERMINATION OF DICAMBA IN WATER, INCLUDING MASS SPECTROMETRIC CONFIRMATION.
Sandoz Crop Protection Corp., Des Plaines, IL.
N. C. Jimenez, Y. H. Atallah, and T. R. Bade.
Journal - Association of Official Analytical Chemists JANCA2, Vol. 72, No. 5, p 840-844, September 1989. 5 fig, 1 tab, 11 ref.

Descriptors: *Pollutant identification, *Water analysis, *Electron capture gas chromatography, *Mass spectrometry, *Herbicides, Groundwater pollution, Dicamba, Benzoic acid, Chemical analysis, Chemical recovery.

A sensitive method is described for determining dicamba at low microg/L levels in groundwaters by capillary column gas chromatography with electron-capture detection (GC-EC); compound identify is confirmed by gas chromatography-mass spectrometry (GC-MS) using selected ion monitoring. Dicamba residue is hydrolyzed in KOH to form the potassium salt. The sample is then extracted with ethyl ether which is discarded. The aqueous phase is acidified to pH < 1 and extracted twice with ethyl ether. The combined ethyl ether extracts are concentrated, and the residue is methylated using diazomethane to form the corresponding dicamba ester. The derivatized sample is cleaned up on a deactivated silica gel column. The methylated dicamba is separated on an SE-30 capillary column and quantitated by electron-capture or mass spectrometric detection. Average recoveries (X +/-SD) for groundwater samples fortified with 0.40 microg/L of dicamba are 86 +/-5% by GC-EC and 97 +/-7% by GC-MS detections. The EDL (estimated detection limit) for this method is 0.1 microg dicamba/L water (ppb). (Author's abstract)
W90-03479

DETERMINATION OF CARBOFURAN AND ITS METABOLITES IN RICE PADDY WATER BY USING SOLID PHASE EXTRACTION AND LIQUID CHROMATOGRAPHY.
FMC Corp., Princeton, NJ. Agricultural Chemical Group.
K. W. Beauchamp, D. D. W. Liu, and E. J. Kikta.
Journal - Association of Official Analytical Chemists JANCA2, Vol. 72, No. 5, p 845-847, September 1989. 3 fig, 15 ref.

Descriptors: *Water analysis, *Chemical analysis, *Pollutant identification, *Pesticides, *Irrigation water, *Liquid chromatography, Detection limits, Rice paddies, *Chemical recovery, Carbofuran, Carbamate, Phenolics.

A procedure for the determination of carbofuran and its metabolites (carbamate and phenolic) in rice paddy water was developed. Water samples are concentrated on a C-18 solid phase extraction (SPE) column and eluted with methanol-water. The eluate is analyzed by reverse-phase liquid chromatography (LC) and measured by a wavelength programmable ultraviolet (UV) detector. The limit of detection for the method is 0.4 microg/L. Recovery studies were carried out at levels ranging from 1 to 15 microg/L in both rice paddy water and distilled water; recoveries ranged from 85.9 to 112.9%. This method is efficient, economical, and reliable for the determination of carbofuran and its metabolites in simple water matrixes. It offers the ability to analyze both phenols and carbamates by using one procedure, and alleviates the problems associated with traditional liquid/liquid extractions and derivatization procedures. (Author's abstract)
W90-03480

COMPARISON OF METHODS FOR THE ENUMERATION OF FECAL COLIFORMS IN TROPICAL WATERS.
Puerto Rico Univ., Rio Piedras. Environmental

Microbiology Lab.
T. C. Hazen, and G. A. Toranzos.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109380/AS, price codes: A03 in paper copy, A01 in microfiche. Final Technical Report, Puerto Rico Water Resources Research Institute, Mayaguez, July 1988. USGS Contract 14-08-0001-G-1446. USGS Project G1446-03.

Descriptors: *Enteric bacteria, *Bacterial analysis, *Coliforms, *Puerto Rico, *Pollutant identification, Water analysis, Membrane filter methods, Water quality.

Four membrane filter methods for the enumeration of fecal coliforms were compared for accuracy, specificity, and recovery. Water samples were taken from 13 marine, 1 estuarine, and 4 freshwater sites around Puerto Rico, from pristine waters, water receiving treated and untreated sewage, and effluent from a tuna cannery and a rum distillery. Differences of 1 to 3 orders of magnitude in the levels of fecal coliforms were observed in some samples by different recovery techniques. Marine water samples gave poorer results, in terms of specificity, selectivity, and comparability, than freshwater samples for all four fecal coliform methods used. The method using Difco m-FC agar with a resuscitation step gave the best overall results; however, even this method gave higher false-positive error, higher undetected-target error, lower selectivity, and higher recovery of nontarget organisms than the method using MacConkey membrane broth, the worst method for temperate waters. All methods tested were unacceptable for the enumeration of fecal coliforms in tropical fresh and marine waters. Since Escherichia coli appears to be a normal inhabitant of tropical waters, fecal contamination may be indicated when none is present. Using fecal coliforms as an indicator is grossly inadequate for the detection of recent human fecal contamination and associated pathogens in both marine and fresh tropical waters. (Hazen-U. Puerto Rico, Piedras)
W90-03556

ACID RAIN IN PUERTO RICO.
Puerto Rico Univ., Mayaguez. Engineering Research Center.
E. D. Osborne.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109398/AS, price codes: A03 in paper copy, A01 in microfiche. Final Technical Report, Puerto Rico Water Resources Research Institute, Mayaguez, November 1986. 30p, 2 fig, 17 tab, 18 ref. USGS Contract 14-08-0001-G-1446. USGS Project G1446-02.

Descriptors: *Acid rain, *Puerto Rico, *Pollutant identification, Water quality, Air pollution, Nitrate ions, Sulfate ions, Chloride ions, Meteorological data, Hydrogen ion concentration, Specific conductivity.

Based on the chemical analysis of some 373 samples of bulk rain collected at 14 sampling locations around Puerto Rico during 1984-85 the problem of acid rain was studied. The pH, conductivity and the concentration of NO3, SO4- and Cl were investigated. Meteorological aspects such as rainfall and wind patterns were also considered. Results obtained show that in almost all the locations the pH was below the 5.6 established for pure rain, with values ranging from 4.2 to 6.1. Maximum concentration values for all ions were found during the dry season. SO4(--) to Cl(-) ratios indicate that much of the SO4(--) comes from sea spray. Data analysis reveal that pH is best correlated to SO4(--), conductivity to Cl(-) and SO4(--) to NO3(-). The lowest rainwater pH was found at locations down wind of densely populated areas. Acid rain although still not a serious problem in Puerto Rico is a phenomenon present in the environment of the island. (Osborne-U. Puerto Rico, Mayaguez)
W90-03557

CHEMICAL MODELING OF A DAIRY WASTE/WATER MANAGEMENT, POLLU-

TION CONTROL SYSTEM FOR FARM MAN-
AGEMENT IN PUERTO RICO.
Puerto Rico Univ., Mayaguez. Dept. of Chemistry.
For primary bibliographic entry see Field 5G.
W90-03559

5B. Sources Of Pollution

SUSPENDED SEDIMENT FLOW MODEL FOR
HIGH SOLIDS CONCENTRATION USING
HIGHER ORDER TURBULENCE CLOSURE.
Southern Illinois Univ. at Carbondale. Dept. of
Civil Engineering and Mechanics.
For primary bibliographic entry see Field 2J.
W90-02550

EFFECTS OF IRRIGATED AGRICULTURE ON
GROUNDWATER QUALITY IN CORN BELT
AND LAKE STATES.
Fuller, Mossbarger, Scott and May, Lexington,
KY.
For primary bibliographic entry see Field 3E.
W90-02569

IRRIGATED AGRICULTURE AND WATER
QUALITY IN SOUTH.
Maryland Univ., College Park. Dept. of Agricul-
tural Engineering.
A. Shirmohammadi, and W. G. Knisel.
Journal of Irrigation and Drainage Engineering
(ASCE) JIDEDH, Vol. 115, No. 5, p 791-806,
October 1989. 4 fig, 6 tab, 44 ref.

Descriptors: *Water quality, *Water pollution
sources, *Groundwater pollution, *Agricultural
hydrology, *Groundwater quality, *Southeastern
United States, *Irrigation effects, *Agricultural
chemicals, Aquifer management, Alluvial aquifers,
Climates, Soil management, Humid areas, Crop
production, Fertilizers, Pesticides, Percolation,
Water resources management, Groundwater reser-
voirs, Drinking water, Nitrates, Coastal plains.

The aquifer systems underlying the Coastal Plain
of the Southeast and Delta states, and the alluvial
aquifers of the Delta states are some of the most
productive groundwater reservoirs in the United
States. Soil, water, and climatic resources make the
region ideally suited for intensive agricultural man-
agement. Irrigated agriculture in the humid region
has resulted in more intensive management includ-
ing crop production and the associated increase in
fertilizer and pesticide use. Multiple cropping in
most of the southeast (Alabama, Florida, Georgia,
and South Carolina) and Delta (Arkansas, Louisi-
ana, and Mississippi) states increases the demand
for water and agricultural chemicals. Agricultural
chemicals may percolate to aquifers in some soils
and geologic formations resulting in groundwater
contamination. Groundwater fluctuations are relat-
ed to irrigation. Groundwater quality data are used
to show the trend in quality related to irrigated
agriculture and cropping systems. Areas with spe-
cific groundwater problems such as salt-water in-
trusion and pesticide levels are identified. A total
of 17 pesticides have been reported in groundwater
in the United States and four of these were found
in the southeast and Delta states had nitrate con-
centrations exceeding 10 mg/L (drinking water
standard). Notable examples of degradation of sur-
face water quality relative to irrigation include the
Everglades agricultural area and Lake Okeechobee
in Florida. Increased irrigation in other southeast
and Delta states have caused nonpoint pollution of
streams from agricultural chemicals. Potential pol-
lution of water and accumulation of pesticides and
phosphorus on bottom sediments of water bodies
are a concern in agricultural areas of Arkansas and
Louisiana. (Fish-PTT)
W90-02570

IRRIGATED AGRICULTURE AND WATER
QUALITY IN EAST.
Delaware Univ., Newark. Dept. of Agricultural
Engineering.
W. F. Ritter, F. J. Humenik, and R. W. Skaggs.
Journal of Irrigation and Drainage Engineering
(ASCE) JIDEDH, Vol. 115, No. 5, p 807-821,

October 1989. 4 tab, 23 ref.

Descriptors: *Water pollution sources, *Water
quality, *Groundwater pollution, *Eastern United
States, *Water quality management, *Humid areas,
*Irrigation effects, Geology, Soil types, Climates,
Groundwater recharge, Corn, Potatoes, Sand,
Poultry, Leaching, Nitrates, Pesticides, Drainage
programs, Subsurface irrigation, Crop yield, Coast-
al plains, Delaware, Maryland, Virginia, New
York, North Carolina.

It has only been in recent years that groundwater
contamination has become recognized as a serious
water quality problem in the humid region. The
northeastern and Appalachian states have a diverse
array of geology, soils, and climate. Irrigation is
concentrated in a few states, with the largest irriga-
tion area in the Coastal Plain soils. Most of these
soils are sandy and very susceptible to leaching.
The groundwater recharge area in the Coastal
Plain is directly above the aquifer. Most of the
increase in irrigation has been to irrigate corn in
Delaware, Maryland, and Virginia. Groundwater
studies have been conducted in Delaware, Mary-
land, and New York in irrigated regions. Nitrate
and aldicarb leaching has occurred on Long
Island, New York, where potatoes are grown.
Poultry manure is the largest source of nitrate
contamination of the water table aquifer on the
Delmarva Peninsula in Maryland. Both pesticide
and nitrate leaching under irrigation have been
studied in Delaware. A total water management
system that can be used for both drainage and
subsurface irrigation has been developed in North
Carolina. The system will increase crop yields and
has the potential for reducing nitrates by water
table control. (Fish-PTT)
W90-02571

IRRIGATION IMPACT ON GROUNDWATER:
MODEL STUDY IN HUMID REGION.
Agricultural Research Service, Tifton, GA. South-
east Watershed Research Center.
W. G. Knisel, and R. A. Leonard.
Journal of Irrigation and Drainage Engineering
(ASCE) JIDEDH, Vol. 115, No. 5, p 823-838,
October 1989. 2 fig, 7 tab, 18 ref.

Descriptors: *Water pollution sources, *Ground-
water pollution, *Irrigation effects, *Groundwater
recharge, *Agricultural hydrology, *Irrigation
practices, *Humid areas, *Model studies, Soil
moisture retention, Crop production, Load distri-
bution, Root zone, Leaching, Pesticides, Climates,
Water quality management.

Coarse-grained soils comprise the groundwater re-
charge areas of the humid region of the United
States. The water-retention capabilities of those
soils are quite low and irrigation is necessary for
good production of agricultural crops. The
Groundwater Loading Effects of Agricultural
Management Systems (GLEAMS) model was ap-
plied to estimate the effects of: (1) soil; (2) planting
date; (3) irrigation level; and (4) pesticide charac-
teristics on pesticide leaching below the root zone
of representative coarse-grained soils. Climate/ap-
plication/pesticide-characteristic interactions are
shown to significantly affect pesticide losses,
whereas irrigation practice has little effect. Persist-
ent and mobile compounds exhibit the highest
losses. (Fish-PTT)
W90-02572

HEAT FLOW DATA AND VERTICAL
GROUNDWATER MOVEMENT, EXAMPLES
FROM SOUTHWESTERN VIRGINIA.
New Mexico Inst. of Mining and Technology,
Socorro.
For primary bibliographic entry see Field 2F.
W90-02580

MODELING THE TRANSPORT OF SOLUTES
INFLUENCED BY MULTIPROCESS NONE-
QUILIBRIUM.
Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 2F.
W90-02586

HISTORICAL RECONSTRUCTIONS AND
FUTURE FORECASTS OF REGIONAL SUR-
FACE WATER ACIDIFICATION IN SOUTH-
ERNMOST NORWAY.
Virginia Univ., Charlottesville. Dept. of Environ-
mental Sciences.
G. M. Hornberger, B. J. Cosby, and R. F. Wright.
Water Resources Research WRERAQ, Vol. 25,
No. 9, p 2009-2018, September 1989. 4 fig, 5 tab, 27
ref.

Descriptors: *Water pollution sources, *Acid rain
effects, *Acidic water, *Acid rain, *Simulation
analysis, *Surface water, *Water quality manage-
ment, *Monte Carlo method, Water quality con-
trol, Lakes, Surveys, Model studies, Regional plan-
ning, Regional analysis, Norway.

Acidic deposition, acidification of surface waters,
and loss of fish populations occur over large re-
gions of northern Europe. A 'regionalization'
methodology uses a conceptual model of long-term
water quality responses to acidic deposition
(MAGIC) in a Monte Carlo simulation framework
to reproduce observed distributions of water qual-
ity variables derived from regional surveys. The
methodology is applied to data from a 1974 survey
of 700 lakes in southernmost Norway to produce a
calibrated model for the region. Predicted water
quality in 1986 agrees well with results from a
resurvey of 300 lakes. The model indicates that
significant acidification occurred in the decades
preceding the survey. The simulated effects of a
30% decrease in 26 years are readily apparent.
Simulations for a 30% reduction indicate little
improvement in water quality in the future. Simu-
lations for a 50% reduction and for a 70% reduc-
tion in deposition indicate substantial and continu-
ing improvement in water quality. The regionaliza-
tion approach is a new and potentially useful
method for modeling impacts of atmospheric
acidic deposition. (Author's abstract)
W90-02589

TOXIC THREAT OF MARINE MAMMALS: IN-
CREASING TOXIC POTENTIAL OF NON-
ORTHO AND MONO-ORTHO COPLANAR
PCBS FROM LAND TO OCEAN.
Ehime Univ., Matsuyama (Japan). Dept. of Envi-
ronment Conservation.
S. Tanabe, N. Kannan, M. Ono, and R. Tatsukawa.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 485-
490, 1989. 3 tab, 12 ref.

Descriptors: *Fate of pollutants, *Dioxins, *Diben-
zofurans, *Water pollution effects, *Population ex-
posure, *Polychlorinated biphenyls, Spatial distri-
bution, Fate of pollutants, Marine animals, Aro-
matic compounds, Chlorinated hydrocarbons,
Coastal waters.

Toxic non-, mono-, and di-ortho coplanar poly-
chlorinated biphenyl (PCB) congeners were deter-
mined in terrestrial and marine mammals. The con-
centrations of coplanar PCBs were found to be
higher in the order of di-ortho > mono-ortho >
non-ortho congeners and were significantly higher
than the levels of toxic dioxins and furans. The
geographical distribution of these chemicals based
on the relative abundance of coplanar PCB con-
geners with reference to total PCBs did not vary in
terrestrial, coastal and open ocean. '2,3,7,8-T4
CDD toxic equivalent analysis' revealed that
higher aquatic predators such as cetaceans receive
a greater toxic threat from 3,3',4,4',5 and
2,3,3',4,4'-pentachlorobiphenyls than PCDFs and
PCDDs. (Author's abstract)
W90-02602

PCDDS AND PCDFS IN DUTCH INLAND
WATERS.
Rijksinstituut voor Zuivering van Afvalwater, Le-
lystad (Netherlands).
E. Turkstra, and H. B. Pols.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 539-
551, 1989. 3 fig, 10 ref.

Descriptors: *Pollutant identification, *The Neth-
erlands, *Aromatic compounds, *Path of pollut-
ants, *Wastewater disposal, *Dioxins, *Dibenzo-

furans, Pentachlorophenol, Rhine River, Meuse River, Fish, Chlorinated hydrocarbons, Effluents, Aquatic environment.

The occurrence of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in selected relevant wastewater discharges and sediments in the Dutch aquatic environment was investigated. The load of PCDDs and PCDFs to the aquatic environment via the studied wastewater discharges appeared to be of minor importance compared to other (diffusive) sources. It was found that the PCDD and PCDF-load from the selected wastewater discharges on the Dutch surface waters is very small (a few g per year) compared to the border crossing load of the Rhine and Meuse rivers (55-80 g/y). PCDD and PCDF-concentrations in sediment ranging from 0.01-0.10 ng/g for standard sediment can be regarded as background levels. For most sediments, these concentrations must have been caused by diffusive sources and border crossing transport of the Rhine and Meuse rivers. The most important diffusive sources are waste incinerators and the use of pentachlorophenol. The use of pentachlorophenol should therefore be restricted. The concentrations in the selected sediments probably do not pose a direct risk to human health. Direct human contact with dredged material from the Chemiehaven and St. Lauraenshaven, in Rotterdam Harbor, however, should be avoided. Concentrations in fish (pike, bream, perch, pike-perch) from the Rhine and Meuse river delta are rather high and, for pike, exceed the limit. (Friedmann-PTT)
W90-02603

POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS IN SELECTED ESTUARINE SEDIMENTS.
Environmental Protection Agency, Narragansett, RI. Environmental Research Lab.
C. B. Norwood, M. Hackett, R. J. Pruell, B. C. Butterworth, and K. J. Williamson.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 553-560, 1989. 5 fig, 2 tab, 7 ref.

Descriptors: *Water pollution sources, *Chlorinated hydrocarbons, *Dioxins, *Dibenzofurans, *Aromatic compounds, *Path of pollutants, *Organic compounds, *Estuaries, *Bottom sediments, Aquatic environment, Water pollution sources, Polychlorinated biphenyls, Pollutant identification, Pentachlorophenol, Isomers, Fate of pollutants, Spatial distribution.

While reports of the concentrations and distributions of polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) in freshwater sediments have been characterized and published, there have been few reports of the distributions of these compounds in marine/estuarine environments. The concentrations of environmentally significant PCDDs and PCDFs were determined for several estuaries, and are compared and contrasted with observed isomer distribution with regard to possible sources of these compounds. It was found that when these isomer distributions were displayed on a log scale, comparisons of various estuarine sediments revealed significant differences. Principal components analyses displayed clusters that suggested relationships with different source materials. PCB contaminated sediments had elevated levels of PCDFs. PCP may be a source of PCDDs in some sediments, and is an endpoint in the principal components plots for this set of data. Principal components analysis based on normalized and log-transformed data seems to quantitate the observed differences in the distributions, and closely group some sets of related samples while contrasting them with other sets. (Friedmann-PTT)
W90-02604

PATTERN ANALYSIS OF PCDDS AND PCDFS IN ENVIRONMENTAL SAMPLES AS AN APPROACH TO AN OCCURRENCE/SOURCE CORRELATION.
Ulm Univ. (Germany, F.R.). Abt. Analytische Chemie.
M. Swerev, and K. Ballschmiter.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 609-616, 1989. 7 fig, 8 ref.

Descriptors: *Water pollution sources, *Aromatic compounds, *Path of pollutants, *Organic compounds, *Dioxins, *Dibenzofurans, *Industrial wastes, *Chemical wastes, Environmental quality, Particulate matter, Polychlorinated biphenyls, Pollutant identification, Chlorinated hydrocarbons.

The environmental pattern of occurrence/source correlation for PCDDs and PCDFs were determined from two primary sources: industrial processes and products based on chlorine chemistry and combustion process in general. The patterns were determined through the profile of the chlorohomologs from Cl1 to Cl8, the PCDD/PCDF ratio of the chlorohomologs, the isomer-specific distribution of compounds of the same degree of chlorination, the pattern of the congeners of the 2,3,7,8-group, and through the pattern of the congeners in general, particularly precursor-typical congeners. Such analysis of the PCDD/PCDF patterns showed that the different thermal processes give rather similar patterns. The observed variations can be explained in terms of defined precursor reactions. The patterns of technical products differ rather strongly and typical ratios of congeners can be taken as an indicator for their contribution to environmental patterns. Results of this analysis showed that no single congener can be used to attribute the occurrence of PCDD/PCDF in a sample to a certain source or sources. For the two particulate standards, NBS SRMs 1648 and 1649 and for the air particulates from Ulm, indicators were found for a mixed input from pentachlorophenol, polychlorobiphenyls and thermal sources. The thermal input could not yet be attributed to the different combustion sources. (Friedmann-PTT)
W90-02605

COMPARISON OF HUMAN EXPOSURE TO DIOXIN FROM MUNICIPAL WASTE INCINERATION AND BACKGROUND ENVIRONMENTAL CONTAMINATION.
Oak Ridge National Lab., TN. Office of Risk Analysis.
H. A. Hattemer-Frey, and C. C. Travis.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 643-649, 1989. 3 tab, 31 ref.

Descriptors: *Dioxins, *Water pollution sources, *Water pollution effects, *Organic compounds, *Aromatic compounds, *Bioaccumulation, *Population exposure, *Incineration, *Public health, *Municipal wastewater, *Path of pollutants, Soil contamination, Chlorinated hydrocarbons.

The pathways and extent of human exposure to dioxin are reviewed. The long-term, average daily intake of dioxin is estimated to be 0.05 ng/day. The food chain is the major source of human exposure to dioxin. Inhalation and fish ingestion are not principal routes of exposure. Accumulation of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) on vegetation involves root uptake and foliar deposition. Because TCDD is highly lipophilic, it readily bioaccumulates in living organisms. Ingestion of contaminated forage and soil represents the major source of TCDD for terrestrial organisms. Two independent methods used to estimate the long-term average daily intake of dioxin yielded estimates of 0.03 and 0.05 ng/day, which agrees well with an earlier reported value. Results showed that municipal waste incineration will not substantially increase human exposure to dioxin, since the estimated maximum daily intake of facility-emitted dioxins and furans is 160 times less than the estimated background daily intake of TCDD. (Friedmann-PTT)
W90-02606

LEVELS, TRENDS AND PATTERNS OF PCDDS AND PCDFS IN SCANDINAVIAN ENVIRONMENTAL SAMPLES.
Umea Univ. (Sweden). Dept. of Organic Chemistry.
C. Rappe, P.-A. Bergqvist, and L.-O. Kjeller.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 651-658, 1989. 1 fig, 5 tab, 6 ref.

Descriptors: *Water pollution sources, *Dioxins, *Dibenzofurans, *Pollutant identification, *Path of pollutants, *Organic compounds, *Aromatic compounds, *Baltic Sea, *Sweden, Incineration, Industrial wastes, Pulp wastes, Kraft mills, Fish populations.

The various emission sources of polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in the Swedish environment were quantified. The major sources into the atmosphere are incineration of various types, e.g. municipal solid waste (MSW) incineration, car exhausts and steel mills. All three of these sources have a typical 'incineration pattern' that can be seen in the background sediments and in air samples and air particulates. A rough estimation based on analyses of a few pulp mills indicate that the emissions from the bleaching plants are smaller than from the incineration sources indicated above. However, these emissions from the pulp mills are sent directly into the water and the present study clearly shows the influence of such point sources on the local environment via findings of pollutants in herring, perch, salmon and sediment samples of the Baltic Sea, and Arctic char in Lake Vattern. (Friedmann-PTT)
W90-02607

MONITORING DIOXINS AND FURANS IN PRECIPITATION SAMPLES.
Ontario Ministry of the Environment, Rexdale. Lab. Services Branch.
For primary bibliographic entry see Field 5A.
W90-02608

DETECTION OF DIOXINLIKE ACTIVITY IN FISH, SEDIMENT, AND SURFACE WIPES USING AN IN VITRO BIOASSAY.
New York State Dept. of Health, Albany. Wadsworth Center for Labs. and Research.
For primary bibliographic entry see Field 5A.
W90-02609

CHLORINATED DIOXIN AND DIBENZOFURAN LEVELS IN SEDIMENTS COLLECTED FROM RIVERS IN VIETNAM, 1984-6.
State Univ. of New York at Binghamton. Dept. of Preventive Medicine.
A. Schecter, B. D. Eitzer, and R. A. Hites.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 831-834, 1989. 1 fig, 2 tab, 10 ref.

Descriptors: *Dioxins, *Dibenzofurans, *Fate of pollutants, *Water pollution sources, *Path of pollutants, *Aromatic compounds, *Pollutant identification, *Stream pollution, *Herbicides, *Agent Orange, *Vietnam, *Sampling, *Bottom sediments, Spatial distribution, Chemical wastes, Organic compounds.

Grab sediment samples were taken from three rivers in Vietnam. These samples represented the industrial south (Saigon River), the Agent Orange sprayed area (Dong Nai River) and the non-industrial north (Red River). Samples were analyzed for the tetra through octa-chloro-homologs of polychlorinated dibenzo-p-dioxins and furans (PCDD/F). The homologs were present in patterns and amounts previously seen for environmental samples. The concentration levels in a given sample differed dramatically from one another but the relative amounts of the various chloro-homologs within a given sample were quite similar to one another. All samples have OCDD as the highest homolog but its concentration ranged from 210-4530 pg/g. The highest concentrations were found in the Saigon River, medium concentrations in the Dong Nai, and the lowest concentrations in the Red River. The pattern of chloro-homologs was also similar to what had been previously seen in the human fat tissue from Vietnam. Overall, it is shown that river sediments in Vietnam are contaminated with PCDD/F. (Friedmann-PTT)
W90-02610

ANALYSIS OF FOG SAMPLES FOR PCDD AND PCDF.
Battelle Columbus Div., OH.
J. Czuczwa, V. Katona, G. Pitts, M. Zimmerman,

Group 5B—Sources Of Pollution

and F. DeRoos.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 847-850, 1989. 1 fig, 1 tab, 7 ref.

Descriptors: *Dioxins, *Dibenzofurans, *Path of pollutants, *Aromatic compounds, *Pollutant identification, *Organic compounds, *Fog, *Air pollution, Sampling, Chlorinated hydrocarbons, Switzerland, Atmospheric water.

Trace levels of PCDD and PCDF were detected in fog samples collected in Dubendorf, Switzerland. The more chlorinated, less toxic isomers predominated. Octachlorodibenzodioxin (OCDD) was the most abundant congener at 0.3-3.1 ng/L. Neither 2,3,7,8-TCDD nor TCDF was detected. Congener class profiles were similar to those reported for air and rain samples, suggesting similar sources. Higher PCDD/PCDF levels in fog compared with reported levels in rain may be due to enhanced particle scavenging by fog. (Author's abstract)
W90-02611

PCDDS AND PCDFS IN THE ENVIRONMENT AS A RESULT OF OUTDOOR CHEMICAL WASTE BURNING AT THE DIEMERZEEDIJK-AMSTERDAM.
Environmental Research Laboratory, Amstelveenseweg 88-90, 1075 XJ Amsterdam, The Netherlands.
H. Heida, K. Olie, and J. Wever.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 1025-1030, 1989. 1 fig, 4 tab, 12 ref.

Descriptors: *Dioxins, *Dibenzofurans, *The Netherlands, *Path of pollutants, *Soil contamination, *Organic pesticides, *Water pollution sources, *Chemical wastes, *Bioaccumulation, *Incineration, Chlorinated hydrocarbons, Aromatic compounds, Organic compounds, Pollutant identification.

PCDDs and PCDFs were found in soil samples of an open-air burning site for chemical waste located near Lake IJmeer, a recreational resort and drinking water basin east of Amsterdam. Rabbits shot at the site were contaminated mainly with the more toxic congeners. The predominant compound was 2,3,4,7,8-penta-CDF. It contributed from 60 to 90% of the total loading of toxicity equivalence factors (TEFs) in the livers. Muscles of the same rabbits hardly contained any PCDDs/PCDFs. Bioconcentration factors for the livers varied between < 0.1 for the less toxic congeners to 76.8 ppt dry weight for the more toxic ones, providing additional evidence of selective accumulation in mammals. (Author's abstract)
W90-02612

EMISSIONS OF PCDDS AND PCDFS FROM A PVC-FIRE IN HOLMSUND, SWEDEN.
Umea Univ. (Sweden). Dept. of Organic Chemistry.
S. Marklund, R. Andersson, M. Tysklind, and C. Rappe.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 1031-1038, 1989. 2 fig, 4 tab, 7 ref.

Descriptors: *Path of pollutants, *Organic compounds, *Aromatic compounds, *Air pollution, *Dioxins, *Dibenzofurans, *Water pollution sources, *Sweden, *Industrial wastes, *Snow sampling, Fumes, Chemical wastes, Sampling, Isomers, Spatial distribution, Gulf of Bothnia, Chlorinated hydrocarbons.

A fire occurred in a plastic carpet company in Holmsund, Sweden, in 1987. A heavy pungent HCl smoke was blown over a small part of the village and out over the Gulf of Bothnia. Quantification of the emissions of PCDDs and PCDFs from the fire was performed through wipe and snow samples taken at various points downwind of the plant. All samples were spike with 6 13C12-labeled PCDD and PCDF isomers before the extraction. The snow samples were filtered and the filters were soxhlet extracted using toluene for 8 h. The water phases were extracted with dichloromethane. The wipe samples were also soxhlet extracted using toluene. Results showed that wipe samples close to the firewall has higher levels of PCDFs than the

action level recommended in Sweden (> 50 ng/sq m); 20 m from the wall the levels of PCDFs had decreased to the action level. Data from PCB and PCP fires have shown orders of magnitudes higher levels of PCDFs than found in this fire. Snow is an excellent matrix for measuring outdoor deposition of PCDDs and PCDFs. An estimation of these two pollutants outside the plant, within a 1500-m radius of the fire, showed a deposition of < 3 mg of dioxin calculated in TCDD equivalents. The pattern of individual PCDD and PCDF congeners found in the snow samples and in the wipe samples is very similar to the pattern from a municipal waste incinerator. (Friedmann-PTT)
W90-02613

TOXIC SIGNIFICANCE OF PLANAR AROMATIC COMPOUNDS IN BALTIC ECOSYSTEM: NEW STUDIES ON EXTREMELY TOXIC COPLANAR PCBS.
Jyvaeskylae Univ. (Finland). Dept. of Chemistry.
J. Tarhanen, J. Koistinen, J. Paasivirta, P. J. Vuorinen, and J. Koivusaari.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 1067-1077, 1989. 2 fig, 4 tab, 28 ref.

Descriptors: *Dioxins, *DDT, *Dibenzofurans, *Lindane, *Toxic wastes, *Water pollution sources, *Population exposure, *Path of pollutants, *Aromatic compounds, *Polychlorinated biphenyls, *Tissue analysis, Ecosystems, Pollutant identification, Animal populations, Organic compounds, Organic pesticides, Baltic Sea, Salmon, Birds, Chlorinated hydrocarbons.

Baltic salmon and white-tailed eagle samples were analyzed for organochlorine compounds, including polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, polychlorinated naphtalenes and toxic coplanar PCBs. In salmon, PCB and DDT residue contents were 0.2-0.3 micrograms/g in fresh muscle. Chlordanes, toxaphene, hexachlorobenzene, alpha-hexachlorocyclohexane and gamma-hexachlorocyclohexane were found at 1-10 ng/g levels. Significant dioxin type toxins found were only 2,3,7,8-tetrachlorodibenzofuran (45-81 pg/g) and 3,3',4,4'-tetrachlorobiphenyl (638-1120 pg/g). Polychloronaphthalene contents in all salmon and eagle samples were of the same order of magnitude ranging from 4 to 85 ng/g. THe highest chlorohydrocarbon contents in eagle samples were for PCB, 462 micrograms/g. Toxaphene, alpha-hexachlorocyclohexane and gamma-hexachlorocyclohexane were not detected in eagles. Levels of polychlorodibenzo-p-dioxins, polychlorodibenzofurans and coplanar PCBs were highest ever reported in wildlife in adult eagle samples, in livers of juvenile eagles and in eagle eggs from South Finland ranging from 1 to 13 ng/g for PCDD/Fs and from 18 to 229 ng/g for coplanar PCBs. Calculation of the TCDD-equivalents of the contents gave heavy dioxin toxicity from the coplanar PCBx, especially from 3,3',4,4',5-pentachlorobiphenyl. (Author's abstract)
W90-02614

CASE STUDY AND PROPOSED DECONTAMINATION STEPS OF THE SOIL AND GROUNDWATER BENEATH A CLOSED HERBICIDE PLANT IN GERMANY.
Dekonta G.m.b.H., Mainz (Germany, F.R.).
For primary bibliographic entry see Field 5G.
W90-02616

OCCURRENCE AND FATE OF PCDDS AND PCDFS IN FIVE BLEACHED KRAFT PULP AND PAPER MILLS.
Environmental Protection Agency, Westlake, OH. Environmental Services Div.
G. Amendola, D. Barna, R. Blosser, L. LaFleur, and A. McBride.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 1181-1188, 1989. 5 ref.

Descriptors: *Dioxins, *Dibenzofurans, *Aromatic compounds, *Path of pollutants, *Fate of pollutants, *Organic compounds, *Pulp wastes, *Kraft mills, Pulp and paper industry, Industrial wastes, Wastewater treatment, Sludge disposal, Chemical wastes, Effluents, Chlorinated hydrocarbons.

Due to earlier findings of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) in fish collected downstream of several pulp and paper mills. Five such mills were subsequently screened to determine, whether the source or sources of 2,3,7,8-TCDD and other polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) were at the plants, and to quantify the untreated wastewater discharge loadings, final effluent discharge loadings, sludge concentrations, and wastewater treatment system efficiency for 2,3,7,8-TCDD and other PCDDs and PCDFs. 2,3,7,8-TCDD and 2,3,7,8-TCDF, were the principal PCDDs and PCDFs found in bleached kraft pulp and paper mill matrices, particularly when considered in light of the EPA's 2,3,7,8-TCDD toxicity equivalents approach. The relative amounts of these two chemicals found in paper mill matrices were variable from mill to mill, but fairly consistent within a given mill. The distributions of 2,3,7,8-TCDD and 2,3,7,8-TCDF between bleached pulps and bleach plant wastewaters were highly variable form bleach line to bleach line. However, for a given bleach line, there was consistency between the distributions of 2,3,7,8-TCDD and 2,3,7,8-TCDF, and for the TCDF/TCDD ratio for the pulp and wastewaters. The distributions of 2,3,7,8-TCDD and 2,3,7,8-TCDF among mill exports (bleached pulps, wastewater sludges, and wastewater effluents) were highly variable for the mills studied. Mass balance calculations were difficult to resolve at two mills due to uncertainty in internal process flows, and 2,3,7,8-TCDD and 2,3,7,8-TCDF findings near the detection limits for certain samples. However, for three mills with fairly reliable flow estimates and detectable levels of TCDD and TCDF, mass balance calculations yielded agreement within + 30%. (Friedmann-PTT)
W90-02617

FIELD AND LABORATORY STUDIES ON THE MOVEMENT AND FATE OF TETRACHLORODIBENZO-P-DIOXIN IN SOIL.
Missouri Univ.-Columbia. Environmental Trace Substances Research Center.
S. Kapila, A. F. Yanders, C. E. Orazio, J. E. Meadows, and S. Cerlesi.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 1297-1304, 1989. 7 fig, 9 ref.

Descriptors: *Dioxins, *Chlorinated hydrocarbons, *Path of pollutants, *Fate of pollutants, *Soil contamination, *Organic compounds, *Organic pesticides, *Times Beach, Soil columns, Plumes, Missouri, Spatial distribution, Percolation, Colloids.

A comprehensive study designed to simulate the 2,3,7,8-tetradichlorodibenzo-p-dioxin (TCDD) contamination incident at Times Beach, Missouri, was undertaken to estimate the rate of loss and transport of TCDD at this and similar sites in the state. Soil column studies were conducted under field and laboratory conditions. The results showed that TCDD is very persistent in soil, and losses through surface photolysis and volatilization are very low. In both field and laboratory studies, the downward movement of TCDD became more pronounced with time. Much of the movement can be attributed to the gravitation and capillary flow of the waste oil in the soil column. The movement is enhanced by the displacement of oil and migration of the colloidal suspension resulting after water is applied to the soil columns as simulated rainfall. The downward movement of TCDD became more pronounced after the second and third applications of uncontaminated waste oil. In all cases, the decrease in concentration of TCDD in the upper layers of the soil columns was accompanied by corresponding increases in the concentration in the lower layers with little or no loss of the total TCDD amounts determined in each column. (Friedmann-PTT)
W90-02619

ACUTE AND CHRONIC TOXICITY OF PRODUCED WATER FROM A NORTH SEA OIL PRODUCTION PLATFORM TO THE CALANOID COPEPOD ACARTIA TONSA.
Shell Research Ltd., Sittingbourne (England). Sit-

tingbourne Research Centre.
For primary bibliographic entry see Field 5C.
W90-02620

SPECIFIC CONGENER PROFILES OF POLY-CHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS IN BLUE MUSSEL IN OSAKA BAY IN JAPAN: AQUEOUS SOLUBILITIES OF PCDDS AND PCDFS.
Setsunan Univ., Neyagawa (Japan). Faculty of Pharamaceutical Sciences.
H. Miyata, K. Takayama, M. Mimura, T. Kashimoto, and S. Fukushima.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 3, p 342-349, 1989. 2 fig, 4 tab, 9 ref.

Descriptors: *Monitoring, *Bioindicators, *Path of pollutants, *Bioaccumulation, *Mussels, *Organic compounds, *Organic pesticides, Industrial wastes, Pollutant identification, Dioxins, Coastal waters, Incineration, Municipal wastes.

Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurnas (PCDFs) were monitored in the coastal waters of Japan using the blue mussel as a biological indicator. The levels of both chemicals were closely related to the number of municipal incinerators and the population densities in the cities adjoining the sampling location. The water solubilities were investigated on a mixture of PCDDs and PCDFs purified from a sample of fly ash from an urban municipal incinerator. The PCDDs and PCDFs were composed of hexa through octachlorinated PCDD congeners and hexa and heptachlorinated PCDF congeners, respectively, as major constituents. Water solubilities of the congeners, were, in decreasing order of relative magnitudes, hexa > hepta > octa > penta > tetrachlorinated congener in PCDDs and hexa > hepta > penta > tetra > octachlorinated in PCDFs. The increased solubility was more pronounced with the increasing number of chlorine atoms in the molecules in both chemicals. Compared to the original compounds (fly ash), PCDDs dissolved in the water included relatively larger amounts of tetra through hexachlorinated congeners and smaller amounts of hepta and octochlorinated ones. The relative increase was tetra > penta > hexa. Similar results were also seen in the case of PCDFs. In consideration of the fact that actual sea water contains significant amounts of particulate matter and dissolved organic matter, it appears that the difference in the solubilities of PCDD and PCDF congeners does not have a great effect on producing the specific congener profiles of PCDDs and PCDFs in the blue mussel. (Friedmann-PTT)
W90-02628

LEVELS OF ZINC, CADMIUM AND LEAD IN SOME MARINE ALGAE FROM AQABA-RED SEA.
Yarmouk Univ., Irbid (Jordan). Dept. of Biological Sciences.
M. N. Mesmar.
Acta Biologica Hungarica ABHUE6, Vol. 39, No. 4, p 345-349, 1989. 1 tab, 18 ref.

Descriptors: *Red Sea, *Path of pollutants, *Algae, *Gulf of Aqaba, *Water pollution sources, *Heavy metals, *Marine algae, Zinc, Cadmium, Lead, Industrial wastes, Jordan, Coastal waters.

Jordan has witnessed a rapid industrial development in the last twenty years. This has lead to the release of waste materials or pollutants into the marine environment, particularly nearby Aqaba Port. The levels of zinc, cadmium and lead were determined in four brown algae, three red algae and four green algal species collected from Aqaba. Three different levels of lead and zinc were exhibited among brown algae; intermediate levels were exhibited among red algae and the lowest level was seen among the green algae. Very low concentrations of camium were found in all examined algal species. The results indicate that the brown algal species Cystosira myrica, Sargassum asperifolium, Sargassum neglectum and Sargassum subrepandum always contain the highest concentrations of lead and zinc, but these algae are less contami-

nated than brown algae from European seas near industrialized areas. (Author's abstract)
W90-02647

SOIL POLLUTION BY ATRAZINE: RESEARCH ON AN EXPERIMENTAL MODEL.
Istituto Bio-Sperimentale di Terapia, Naples (Italy).
B. Loscalzo, A. Lucisano, A. Crisci, A. Agrusta, and M. Amorena.
Archives of Toxicology (Supplement) ATSUDG, No. 13, p 394-397, 1989. 3 tab, 4 ref.

Descriptors: *Path of pollutants, *Herbicides, *Food chains, *Water pollution sources, Degradation, Vegetation, Absorption, Leaching.

Soil was evaluated for the various transformations of atrazine (ATZ): (1) watered just once onto the surface of the soil; (2) the penetration of ATZ into the lower layers of the soil; (3) the elimination of both ATZ and its metabolites by means of water drainage in relation to the amount of water supplied (artificial rain); and (4) the absorption of ATZ by vegetation which could eventually develop on the soil. Researchers used a formica container (1 square meter side by 0.35 m high) filled with 200 kg of pasture soil (20 cm high). Ten liters of water containing 40 of Fogard (Erba), a commercial herbicide were watered onto the surface of the soil. The container was tilted to allow for drainage. Results show that the ATZ did not undergo any important change during the entire year of observation, and the ATZ residue in the soil after one year was much higher than some reports found in literature. The proportion of ATZ measured in the form of two metabolites was lower in the surface area, greater throughout the whole of the soil, and reached maximum in the bottom of the container. The proportion of ATZ metabolized in one year (as deethylated-atrazine and deisopropylated-atrazine) was 1.32%. The amount of ATZ measured in the drained water collected from the soil was between 1 and 5 parts per million. ATZ was found in the vegetation, and should be considered when compared with quantities throughout the soil. (Male-PTT)
W90-02654

WATER BUDGET MODEL FOR THE TROPICAL MAGELA FLOOD PLAIN.
Office of the Supervising Scientist for the Alligator Rivers Region, Sydney (Australia).
I. M. Vardavas.
Ecological Modelling ECMODT, Vol. 46, No. 3/4, p 165-194, August 1989. 11 fig, 2 tab, 13 ref.

Descriptors: *Flood plains, *Hydrologic budget, *Rainfall rate, *Mine drainage, *Water pollution sources, *Flow discharge, Discharge frequency, Water depth, Tropical regions, Magela flood plain, Australia, Path of pollutants, Flood plains, Hydrologic models.

A water budget model was developed for the tropical Magela flood plain, which is located downstream from the Ranger uranium mine in the Northern Territory, Australia. Using input data on rainfall and water discharge from Magela Creek, the model provides daily estimates of the volume of surface water on the flood plain and the rate of discharge at the outlet of the flood plain. Annual variations in the relationship between gage height and rate of discharge at the outlet are interpreted in terms of a correlation between early wet-season rainfall and seed germination on the flood plain. The daily volume of water on the flood plain can be used to estimate the dilution and subsequent evapoconcentration of any waterborne contaminants that may be transported by Magela Creek from the mine site downstream to the flood plain. The model was validated by testing its ability to predict the measured daily water depth at the outlet channel; comparison of prediction with 12 years' data produced an average error of about 16%. (Author's abstract)
W90-02658

APPLICATION OF AN INVERSE APPROACH TO A CANADIAN RADIOACTIVE WASTE DISPOSAL SITE.

National Water Research Inst., Burlington (Ontario).
A. G. Bobba, and S. R. Joshi.
Ecological Modelling ECMODT, Vol. 46, No. 3/4, p 195-211, August 1989. 7 fig, 7 tab, 19 ref.

Descriptors: *Path of pollutants, *Water pollution sources, *Radioactive waste disposal, *Radium radioisotopes, *Groundwater pollution, Lake Ontario, Model studies, Finite element method, Waste disposal.

A finite element groundwater contamination model was coupled with an inverse approach to estimate the contaminant transport parameters for radioactive wastes. The model was then used to predict the migration of radium 226 from the near shore Port Granby radioactive disposal site to Lake Ontario. Good agreement was found between model-predicted and observed radium 226 concentrations. Assuming that the pertinent site parameters remain unchanged, the model further predicts that continuous migration, via groundwater, of radium 226 toward Lake Ontario is likely to persist even after the waste is removed from the site. (Author's abstract)
W90-02659

RATIOS OF DRY TO WET DEPOSITION OF SULFUR AS DERIVED FROM PRELIMINARY FIELD DATA.
National Oceanic and Atmospheric Administration, Oak Ridge, TN. Atmospheric Turbulence and Diffusion Div.
B. B. Hicks, T. P. Meyers, C. W. Fairall, V. A. Mohnen, and D. A. Dolske.
Global Biogeochemical Cycles GBCYEP, Vol. 3, No. 2, p 155-162, June 1989. 5 fig, 16 ref.

Descriptors: *Acid rain, *Water pollution sources, *Sulfates, United States, Seasonal distribution, *Deposition.

Preliminary data obtained in the operation of a nested-network dry deposition measurement program in the eastern United States are used in conjunction with wet deposition data obtained at (or near) the same sites to investigate the variability of ratios of dry to wet deposition of sulfur (as sulfur dioxide and submicron sulfate for dry deposition, and as sulfate for wet deposition). On a monthly basis, the ratio is extremely variable at every location; however, a more coherent picture arises when the average annual cycle is considered. The sites studied (Oak Ridge, Tennessee; State College, Pennsylvania; Whiteface Mountain, New York; and Bondville, Illinois) yield dry/wet ratios for sulfur deposition that minimize in the summer, with values of about 0.3. At other times of the year, values sometimes exceeding 2.0 are obtained. A summer peak at Oak Ridge is tentatively attributed to the effects of a local drought. The variability is such that use of dry/wet ratios to estimate dry deposition rates when only wet deposition data are available cannot be recommended. (Author's abstract)
W90-02662

ROLE OF OLIGOCHAETES IN THE MANAGEMENT OF WATERS.
Rijksinstituut voor Natuurbeheer, Leersum (Netherlands).
For primary bibliographic entry see Field 5A.
W90-02665

EJECTION OF DROPS FROM THE SEA AND THEIR ENRICHMENT WITH BACTERIA AND OTHER MATERIALS: A REVIEW.
State Univ. of New York at Albany. Atmospheric Sciences Research Center.
D. Blanchard.
Estuaries ESTUDO, Vol. 12, No. 3, p 127-137, September 1989. 8 fig, 82 ref. NSF Grant no. ATM-8514211.

Descriptors: *Reviews, *Bacteria, *Air pollution, *Aerosols, *Marine environment, Sea spray, Bubbles, Health hazards, Contamination, Jet drops, Toxins.

Group 5B—Sources Of Pollution

A review of work done on the production of an aerosol by the sea, and on the mechanisms by which bacteria might be enriched on the aerosol is presented. Air bubbles produced in the sea, primarily by breaking waves, burst at the surface to eject both film and jet drops into the atmosphere. These drops are mixed upward by turbulence to produce the well-known marine sea-salt aerosol. In rising through the water, the bubbles may scavenge bacteria which, when the bubble bursts, are skimmed off the bubble and ejected upward with the jet drops. Depending on the drop size, the distance the bubble moves through the water, and other factors, the concentration of bacteria in jet drops can be several hundred times that in the bulk water. Film drops can also be enriched with bacteria. The enrichment of jet and film drops with bacteria, viruses, or toxins may at times produce a health hazard for those living along the shore. (Author's abstract)
W90-02707

MODELING FATE AND TRANSPORT OF NU-TRIENTS IN THE JAMES ESTUARY.
Virginia Univ., Charlottesville. Dept. of Civil Engineering.
W. S. Lung, and N. Testerman.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 115, No. 5, p 978-991, October 1989. 7 fig, 1 tab, 12 ref.

Descriptors: *Nutrient removal, *Algal control, *Phosphorus, *Virginia, *Water pollution control, *Fate of pollutants, *Path of pollutants, Model studies, James Estuary, Water pollution sources, Municipal wastewater.

A modeling study was performed for the entire James River Estuary to quantify the fate and transport of nutrients in the system. Model calibration and sensitivity analyses were conducted using data from 1976 and 1983. The verified model was then used to predict the effect of phosphorus control on the water quality in the lower estuary. Control measures to reduce phosphorus loads to the bay include phosphate detergent bans and removal of phosphorus at the wastewater treatment plants in the bay region. A numerical tagging technique was used to track the fate and transport of phosphorus along the entire estuary. Municipal treatment plants in the upper estuary are contributing about 75% of the total algal biomass in the water column. Upstream (primarily nonpoint) and downstream boundary conditions provided another 15% of the algal biomass. While a phosphate detergent ban could reduce the peak algal biomass concentration by 16 to 30% in the upper estuary under the 7-day 10-year flow condition, reducing municipal treatment plant effluent phosphorus concentrations to 2 mg/L could cut the peak algal biomass level by half. (Author's abstract)
W90-02721

SELECTION OF RECEPTOR SITES FOR OPTI-MIZED ACID RAIN CONTROL STRATEGIES.
Texas A and M Univ., College Station. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W90-02724

URBAN STORM RUNOFF EFFECTS ON EX-CHANGEABLE CATIONS AND PERCOLAT-ING WATER CONSTITUENTS BELOW RE-CHARGE BASINS.
Agricultural Research Service, Fresno, CA. Water Management Research Lab.
H. Nightingale.
Soil Science SOSCAK, Vol. 148, No. 1, p 39-45, July 1989. 4 fig, 2 tab, 20 ref.

Descriptors: *Storm runoff, *Water pollution sources, *Urban runoff, *Artificial recharge, *Cations, Soil water, Groundwater quality, Recharge basins.

The disposition of the major cations and anions in the alluvium deposits of a recharge basin, percolating water, and the mound of soil water below the basin in Fresno, CA, were investigated relative to a nearby control site as a component of the EPA's

Nationwide Urban Runoff Program. The study basin received urban storm-water runoff from a residential area for 16 yr. The recharge effects to a 21-m depth were an increase in exchangeable calcium and potassium, a decrease in exchangeable magnesium, and a minor increase in exchangeable sodium with depth. The concentrations of the major dissolved cations and anions in the urban residential storm-water runoff were low. These ions were not detrimental to the physicochemical properties of the surface soils or deep alluvium strata or to the groundwater quality resulting from recharging urban residential stormwater runoff. (Author's abstract)
W90-02738

INFLUENCE OF PH ON CADMIUM AND ZINC CONCENTRATIONS OF CUCUMBER GROWN IN SEWAGE SLUDGE.
Maryland Univ., College Park. Dept. of Horticulture.
A. Falahi-Ardakani, K. A. Corey, and F. R. Gouin.
Hortscience HJHSAR, Vol. 23, No. 6, p 1015-1017, Dec 1988. 1 fig, 1 tab, 16 ref.

Descriptors: *Sludge utilization, *Cadmium, *Zinc, *Bioaccumulation, Sulfur, Cucumbers, Hydrogen ion concentration, Crop production.

Parthenocarpic cucumber (Cucumis sativus L. 'La Reine') plants were grown in the greenhouse in containers filled with equal parts by volume of peatmoss and vermiculite blended with 0%, 25%, or 50% by volume compost made from ferric-chloride-precipitated, lime-stabilized, digested sewage sludge composted with woodchips and amended with various rates of sulfur. The Cd concentration of leaf and fruit samples from plants grown in media amended with 25% or 50% compost and S at 0, 10, 20, or 40 g/L was unaffected by changes in pH from 7.2 to 3.4. However, Zn concentration in fruit samples from plants grown in media amended with 25% compost and S at 40 g/L increased relative to other rates of S, whereas Zn concentration of leaf tissue was unaffected by rate of S application. Yield of fruit was not significantly affected by any of the treatments. Cucumber plants can be grown successfully in media amended with as much as 50% composted sewage sludge low in heavy metal content and over a wide range of pH values without the accumulation of fruit Cd levels reaching concentrations hazardous to human health. (Author's abstract)
W90-02741

INTER- AND INTRALAKE DISTRIBUTIONS OF TRACE ORGANIC CONTAMINANTS IN SURFACE WATERS OF THE GREAT LAKES.
Inland Waters Directorate, Burlington (Ontario). Water Quality Branch.
R. J. J. Stevens, and M. A. Neilson.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 3, p 377-393, 1989. 7 fig, 6 tab, 48 ref.

Descriptors: *Pesticides, *Great Lakes, *Organic pesticides, *Polychlorinated biphenyls, *Chlorobenzenes, *Water pollution, *Path of pollutants, Lindane, Endrin.

Concentrations of organochlorine pesticides, polychlorinated biphenyls (PCBs), and chlorobenzenes (di-to hexa-) were determined on large volume surface water samples collected throughout Lakes Ontario, Erie, Huron, and Superior in the spring of 1986. Analysis of variance revealed that all trace organic contaminants exhibited significant (p <0.05) differences between lakes. Chlorobenzenes, being derived from ongoing manufacturing and usage, exhibited highest concentrations in the lower lakes while those compounds whose principal source is atmospheric deposition displayed no discernable distribution patterns. Lake Ontario could be considered the most heavily impacted of the lakes as it ranked highest in mean concentration for all chlorobenzenes, PCBs, lindane, endrin, and p,p'-DDE. Determinants of large-scale spatial patterns of contaminants varied between lakes. Minor north-south gradients in contaminant concentrations in Lake Superior appeared largely a function of differences in atmospheric loading. In

contrast, large gradients were evident in Lake Erie, a result of numerous tributary point sources, particularly in the western basin. Spatial distribution of contaminants in Lake Huron resulted primarily from inputs from Saginaw Bay, the Serpent/Spanish rivers, and the Black River/Lake Michigan at the Straits of Mackinac. The Niagara River was the most important determinant of spatial patterns of contaminants in Lake Ontario, especially with respect to the chlorobenzenes. Dramatic increases in the concentrations of chlorobenzenes were observed between eastern Lake Erie and the Niagara River plume in Lake Ontario. (Author's abstract)
W90-02745

SUSPENDED SEDIMENTS AND THE DISTRI-BUTION OF BOTTOM SEDIMENTS IN THE NIAGARA RIVER.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 2J.
W90-02749

EVALUATION OF POLLUTION LOADINGS FROM URBAN NONPOINT SOURCES: METH-ODOLOGY AND APPLICATIONS.
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5A.
W90-02751

PARTITIONING AND TRANSPORT OF 210PB IN LAKE MICHIGAN.
Wisconsin Univ.-Madison. Water Chemistry Program.
P. L. Van Hoof, and A. W. Andren.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 3, p 498-509, 1989. 6 fig, 1 tab, 34 ref. Federal Grant No. NA80AA-D-00086, Projects R/MW-24 and R/MW-37.

Descriptors: *Lake Michigan, *Great Lakes, *Heavy metals, *Lead radioisotopes, *Path of pollutants, Sediment transport, Particulate matter, Biogeochemistry, Distribution, Partitioning, Particulate mass flux.

In order to determine what biogeochemical factors control particle-mediated transport of reactive metals in Lake Michigan, 210Pb activities in dissolved and size-fractioned particulate phases were examined as a function of season and depth at an offshore station. Hypolimnetic 210Pb distribution coefficients (Kds) calculated for suspended material collected April-December 1982 vary by less than a factor of six. Higher variability occurs for log Kd values of the 111-21 micrometer fraction (4.8-6.0), while the finer particles (6-1 micrometer), making up a larger contribution to the total mass, have log Kd values that are less variable and higher in magnitude (6.1-6.7). In the epilimnion, log Kd ranges are similar to those of the hypolimnion, except during August. During this period of calcite precipitation, Kd values are one and two order of magnitude greater at 10 m than at deeper depths for the 6-1 micrometer and 111-21 micrometer fractions, respectively. Partitioning of 210Pb to 6-1 micrometer particles in trapped material is similar to that of their suspended counterpart; trapped 111-21 micrometer particles have higher Kd values than suspended 111-21 micrometer particles. The particle size relationship of 210Pb activity measured in trapped material indicates that the processing and packaging of 210Pb -associated particles by zooplankton results in enriched activities in the larger fecal material. Despite changes in the composition and morphology of sedimenting particles, the total mass distribution coefficients of 210Pb remain fairly constant, varying by less than a factor of six. The major factor influencing the seasonal variability of 210Pb removal is the particulate mass flux. (Author's abstract)
W90-02756

ANTHROPOGENIC IMPACTS ON SNIARDWY LAKE (POLAND).
Wroclaw Technical Univ. (Poland). Inst. of Inor-

ganic Chemistry and Metallurgy of Rare Elements. For primary bibliographic entry see Field 5A.
W90-02757

UNIQUE LIMNOLOGICAL PHENOMENA AFFECTING WATER QUALITY OF HAMILTON HARBOUR, LAKE ONTARIO.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
J. Barica.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 3, p 519-530, 1989. 9 fig, 44 ref.

Descriptors: *Lake Ontario, *Limnology, *Water pollution control, *Path of pollutants, *Water pollution sources, *Eutrophication, Mixing, Chlorophyll, Phosphorus, Nitrogen, Chlorophyta, Cyanophyta, Water exchange.

Some unique limnological features and phenomena of Hamilton Harbour, namely (1) substantial exchange of water with Lake Ontario through a ship canal reducing the harbor's residence time by sixty percent, diluting concentrations of pollutants and oxygenating its hypolimnetic water; (2) a high degree of physical variability, resulting in oscillations, mixing, and unstable thermal structure; (3) high concentrations of suspended matter and reduced light regime controlling the development and composition of algal blooms; (4) discrepancy in the total phosphorus versus chlorophyll relationship; and (5) extremely high nitrogen to phosphorus ratios (over 100:1), favoring chlorophytes rather than more objectionable cyanophytes), are analyzed and their ameliorating effects on water quality assessed. These phenomena prevent the water quality of the harbor from reaching critical conditions, considering the high loading rates of nutrients and contaminants. Without their beneficial effects, the concentrations of pollutants per unit volume and algal biomass would be about fifty percent higher. (Author's abstract)
W90-02758

DIFFERENCES BETWEEN THE ACTUAL AND NATURAL WATER QUALITY IN A SMALL DRAINAGE AREA WITH A HIGH LEVEL OF GROUNDWATER DISCHARGE.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
W. Bleuthen.
Hydrological Sciences Journal HSJODN, Vol. 34, No. 5, p 575-588, Oct 1989. 8 fig, 9 ref.

Descriptors: *Surface-groundwater relations, *Path of pollutants, *The Netherlands, *Water pollution sources, *Model studies, Watersheds, Groundwater, Precipitation, Nitrate, Storms, Overland flow, Baseline studies.

In the central part of the Netherlands, a 20 sq km drainage basin contains a morainic ridge of Pleistocene sandy deposits and a backswamp area where the sandy subsoil is covered with river clay deposits. Agricultural and 'natural' ecosystems are present in both parts. A continuous groundwater flow exists from the ridge to the clay area. A channel network drains the area. For these channels a two-dimensional model for simulating discharge and water quality has been developed. In computations, discharges and concentrations in groundwater, precipitation, and overland flow are treated separately. With a model option for calculating the effects of land use changes, water quality was calculated for base-line conditions. Mean nitrate concentrations were 1/2 to 1/7 of the actual concentrations, mainly caused by manure inputs. Storm events occasionally give very high concentrations, also under base-line conditions. Therefore base-line conditions for ions cannot be described as a single steady value. (Author's abstract)
W90-02763

NATIONAL EVALUATION OF THE LEACHING POTENTIAL OF ALDICARB, PART I: AN INTEGRATED ASSESSMENT METHODOLOGY.
Environmental Protection Agency, Washington, DC.
M. N. Lorber, S. Z. Cohen, S. E. Noren, and G.

D. DeBuchananne.
Ground Water Monitoring Review GWMRDU, Vol. 9, No. 4, p 109-125, 1989. 13 fig, 4 tab, 26 ref.

Descriptors: *Pesticides, *Path of pollutants, *Groundwater pollution, *Agricultural chemicals, *Leaching, *Aldicarb, Monitoring, Geohydrology, Crops.

A methodology was developed to determine the potential for aldicarb to leach to ground water and appear at or near concentrations of concern in different areas of the continental United States. Aldicarb use in 11 'ground water regions', as defined by Heath, was evaluated. These regions were selected based on significant use of aldicarb on citrus, cotton, potatoes, peanuts, and soybeans. The unit of study, therefore, became known as crop/Heath-Region combinations' (CHRCs). A total of 32 CHRCs were evaluated. Three measures of leaching potential were used to evaluate each CHRC. One was based on hydrogeologic vulnerability, one was based on agronomic and site-specific characteristics, and one was based on ground water monitoring data. Each measure was rated as 'high', 'medium', 'low' or 'insufficient data' in terms of potential for aldicarb to leach for crop-growing areas in the region. Using a weight-of-evidence approach, each CHRC was given a final rating of 'high', 'medium', and 'low' potential to leach based on the three measures within the CHRC. Potatoes in Heath Regions 7 (Glaciated Central) and 9 (Northeast and Superior Uplands) were rated high, whereas potatoes in Regions 1 (Western Mountain Ranges), 3 (Columbia Lava Plateau), and 11 (Southeast Coastal Plain) were rated low. Cotton in Regions 1, 2 (Alluvial Basins), 5 (High Plains), 10B (Gulf Coastal Plain), and 11 were rated low. Citrus and peanuts in Region 11 were rated high. All other CHRCs, including all soybean CHRCs, were rated medium. (Author's abstract)
W90-02766

PESTICIDES IN NEBRASKA'S GROUND WATER.
Nebraska Univ.-Lincoln. Dept. of Agronomy.
R. F. Spalding, M. E. Burbach, and M. E. Exner.
Ground Water Monitoring Review GWMRDU, Vol. 9, No. 4, p 126-133, 1989. 3 fig, 2 tab, 28 ref.

Descriptors: *Groundwater pollution, *Water quality, *Water pollution sources, *Nebraska, *Wells, *Pesticides, *Agricultural chemicals, Sampling, Atrazine, Corn, Cyanazine, Triazines, Contamination, Alachlor, Propachlor, Metalachlor.

More than 2263 well water samples were collected throughout Nebraska and analyzed for pesticides. Thirteen and one-half percent contained detectable levels of atrazine, but only 22 wells exceeded the health advisory of 3.0 ppb. Although the samples came from almost every county in the state, this sampling is not based solely on a randomly selected group of wells. The highest frequency of detections occurred in irrigated corn-growing areas with less than 50 feet to ground water. These areas were sampled at a greater frequency than the less vulnerable areas. Cyanazine, together with the additional triazines--simazine, propazine, prometone, and ametryne, also were detected in some well waters; however, their frequency of detection was well below that of atrazine. The triazine metribuzin was not detected. Alachlor, propachlor, and metolachlor also were detected in trace levels in several wells. Five of 2072 samples analyzed for alachlor exceeded the health advisory of 0.4 ppb. Almost all of the contaminated wells were in vulnerable areas. The relatively high frequency of propachlor detections occurred in predominately irrigated corn-growing areas, rather than in areas where propachlor is traditionally applied. The factors that appear most directly involved in the observed distribution of pesticides in ground water are the intensity of areal usage, pesticide persistence and mobility, irrigation, soil drainage capacity, and depth to ground water. Fifteen pesticide residues were detected during this study. If ethylene dibromide and carbon tetrachloride, which were detected in ground water adjacent to grain elevators are included, a total of 17 pesticide residues have been detected in Nebraska's ground water. (Author's abstract)

W90-02767

CONTAMINATION OF THE SANDSTONE AQUIFER OF PRINCE EDWARD ISLAND, CANADA BY ALDICARB AND NITROGEN RESIDUES.
National Water Research Inst., Burlington (Ontario).
M. W. Priddle, R. E. Jackson, and J. P. Mutch.
Ground Water Monitoring Review GWMRDU, Vol. 9, No. 4, p 134-140, 1989. 8 fig, 3 tab, 19 ref.

Descriptors: *Water pollution sources, *Canada, *Prince Edward Island, *Agricultural chemicals, *Groundwater pollution, *Aldicarb, Nitrates, Hydrogen ion concentration, Drinking water, Ammonium, Persistence.

Prince Edward Island is wholly dependent upon ground water from a highly permeable fractured sandstone aquifer for all industrial, domestic, agricultural, and potable uses. The contamination of this aquifer by agricultural residues, principally aldicarb and nitrate, has caused concern among Islanders. Ground water quality was monitored between 1985 and 1988 beneath two potato fields to which aldicarb (Temik) was applied at planting once or twice between 1983 and 1986. In May of 1988, 12 percent of 48 monitoring well samples exceeded the drinking water guideline of 9 micrograms/L for total aldicarb. Furthermore 32 percent of all samples exceeded the nitrate guideline of 10 mg/L. Aldicarb persistence appears related to its application at planting when soil temperatures are low and recharge is high and to the inhibiting pH effect that ammonium (from fertilizers and soil organic nitrogen) oxidation has on its degradation. Therefore, based on the research of others, it is recommended that aldicarb be applied at plant emergence when degradation is more rapid and recharge is lower. (Author's abstract)
W90-02768

GROUND WATER LOADING OF PESTICIDES IN THE ATLANTIC COASTAL PLAIN.
Maryland Univ., College Park. Dept. of Agricultural Engineering.
A. Shirmohammadi, W. L. Magette, R. B. Brinsfield, and K. Staver.
Ground Water Monitoring Review GWMRDU, Vol. 9, No. 4, p 141-148, 1989. 6 fig, 7 tab, 25 ref.

Descriptors: *Path of pollutants, *Water quality, *Pesticides, *Model studies, *Groundwater pollution, *Agricultural chemicals, *Mathematical models, GLEAMS model, Leaching, Pesticides.

Pollution of ground water by agricultural practices has gained considerable attention in recent years. Mathematical models have been developed to evaluate the effects of agricultural best management practices on pesticide transport to ground water. The GLEAMS model was evaluated to determine its suitability for use in predicting managerial effects on pesticide leaching from agricultural systems in the Atlantic Coastal Plain. Model predictions of pesticide concentrations in percolation from the root zone were compared to observed concentrations in ground water beneath field-sized areas. The model underpredicted runoff from these areas. Model predictions were used to produce rankings of the magnitudes of pesticide losses that paralleled rankings of observed ground water data in some cases but not others. Differences in observed and predicted rankings were assessed to be the result of sampling schedule inefficiencies. The magnitudes of predicted pesticide concentrations in leachate from the root zone were three to seven times higher than observed concentrations in shallow ground water. Results support the use of GLEAMS for comparison of managerial effects on pesticide movement to ground water if appropriate limitations are recognized. (Author's abstract)
W90-02769

WET, OCCULT AND DRY DEPOSITION OF POLLUTANTS ON FORESTS.
Nottingham Univ. (England). Dept. of Physiology

and Environmental Science.
M. H. Unsworth, and J. C. Wilshaw.
Agricultural and Forest Meteorology AFMEEB, Vol. 47, No. 2-4, p 221-238, Sep 1989. 4 fig, 3 tab, 57 ref.

Descriptors: *Air pollution, *Acid rain, *Forests, *Clouds, Deposition, Path of pollutants, Cloud chemistry, Nitric acid, Hydrochloric acid, Model studies.

Mechanisms by which air pollutants are transferred to forests by wet and dry deposition and in wind-driven cloud water (occult deposition) are reviewed. In upland forests, orographic cloud can enhance the amount of ionic concentration of precipitation so that wet deposition may be 4-5 times larger than in nearby valleys. Recent work supports the use of a simple aerodynamic relation to estimate rates of occult deposition. Occult deposition rates to forests in identical weather conditions may vary by an order of magnitude depending on forest structure. Evaporation of deposited water may cause the solute concentration of water on foliage to be substantially larger than in cloud. Dry deposition of HNO3 and HCl is controlled by aerodynamic properties of the canopy. Several kg N/ha/year are deposited to forests by this path. Transfer of SO2, H2O2 and O3 is restricted by surface and internal resistances of foliage. Controls of dry deposition of ammonia and nitrogen oxides and of particles are not well known. A canopy transfer model 'Maestro' was modified to include gaseous pollutants and agrees well with measured SO2 fluxes to a forest. Estimates of wet, occult and dry deposition on Keilder Forest, England, and Whitetop Mountain, U.S.A., show substantial differences in occult deposition which are only partly explained by differences in cloud frequency. Regional cloud chemistry probably differs between the sites, and different models of occult deposition also disagree. (Author's abstract)
W90-02780

EVIDENCE FOR A NEW PATHWAY IN THE BACTERIAL DEGRADATION OF 4-FLUORO-BENZOATE.
Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Mikrobiologie.
R. H. Oltmanns, M. Muller, M. K. Otto, and F. Lingens.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 10, p 2499-2504, 1989. 5 fig, 3 tab, 46 ref.

Descriptors: *Bacterial physiology, *Benzenes, *Fluorobenzoic acid, *Biodegradation, *Fate of pollutants, *Microbial degradation, Bacterial strains, Enzymes, Alcaligenes, Pseudomonas, Aureobacterium.

Six bacterial strains able to use 4-fluorobenzoic acid as their sole source of carbon and energy were isolated by selective enrichment from various water and soil samples from the Stuttgart area. According to their responses in biochemical and morphological tests, the organisms were assigned to the genera Alcaligenes, Pseudomonas, and Aureobacterium. To elucidate the degradation pathway of 4-fluorobenzoate, metabolic intermediates were identified. Five gram-negative isolates degraded this substrate via 4-fluorocatechol, as described in previous studies. In growth experiments, these strains excreted 50 to 90% of the fluoride from fluorobenzoate. Alcaligenes sp. strains RHO21 and RHO22 used all three isomers of monofluorobenzoate. Alcaligenes sp. strain RHO22 also grew on 4-chlorobenzoate. Aureobacterium sp. strain RHO25 transiently excreted 4-hydroxybenzoate into the culture medium during growth on 4-fluorobenzoate, and stoichiometric amounts of fluoride were released. In cell extracts from this strain, the enzymes for the conversion of 4-fluorobenzoate, 4-hydroxybenzoate, and 3,4-dihydroxybenzoate could be detected. All these enzymes were inducible by 4-fluorobenzoate. These data suggest a new pathway for the degradation of 4-fluorobenzoate by Aureobacterium sp. strain RHO25 via 4-hydroxybenzoate and 3,4-dihydroxybenzoate. (Author's abstract)
W90-02784

REDUCTIVE DEHALOGENATION OF DICHLOROANILINES BY ANAEROBIC MICROORGANISMS IN FRESH AND DICHLORO-PHENOL-ACCLIMATED POND SEDIMENT.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
J. Struijs, and J. E. Rogers.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 10, p 2527-2531, 1989. 5 fig, 1 tab, 25 ref.

Descriptors: *Fate of pollutants, *Bacterial physiology, *Anaerobic bacteria, *Chloroanalines, Dechlorination, Sediments, Acclimatization, Chlorophenol.

The transformation of 2,4-dichloroaniline (2,4-DiCA) and 3,4-DiCA to monochloroanilines (CA) in anaerobic pond sediment was investigated. Dechlorination of 3,4-DiCA to 3-CA started after a lag period of 3 weeks and was complete after an additional 5 weeks. Although 2,4-DiCA disappeared over 8 weeks, the appearance of a CA product could not be detected. In contrast, anaerobic bacteria in pond sediment acclimated to dehalogenate 2,4-dichlorophenol (2,4-DiCP) or 3,4-DiCP rapidly dechlorinated 2,4-DiCA and 3,4-DiCA without any lag time. By comparison, anaerobic sediment bacteria acclimated to 3,4-DiCA rapidly degraded 3,4-DiCP without a lag. In all cases, the CA products were stable for the duration of the experiments. It is concluded that cross-acclimation occurred. (Author's abstract)
W90-02785

DIRECT PHENOTYPIC AND GENOTYPIC DETECTION OF A RECOMBINANT PSEUDOMONAD POPULATION RELEASED INTO LAKE WATER.
Liverpool Univ. (England). Dept. of Genetics and Microbiology.
J. A. W. Morgan, C. Winstanley, R. W. Pickup, J. G. Jones, and J. R. Saunders.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 10, p 2537-2544, 1989. 11 fig, 2 tab, 36 ref.

Descriptors: *Pollutant identification, *Fate of pollutants, *Microbiological studies, *Microorganisms, *Genetic engineering, Lakes, Detection limits, Pseudomonas, Growth, Enzymes.

As a system for studying the fate of genetically engineered microorganisms in the environment, recombinant plasmids encoding a xylE marker gene was previously constructed. A series of direct membrane filter methods have been developed which facilitate the detection of bacterial cells harboring the xylE gene, its product, catechol 2,3-dioxygenase, and catechol 2,3-dioxygenase enzyme activity directly from water samples. These methods enable detection of recombinant populations at concentrations as low as 10000 to 100000 cells/ml of lake water. Direct detection facilitates ecological studies of a range of bacterial strains containing the marker system in aquatic environments. The fate of a recombinant pseudomonad population in lake water was assessed by a combination of colony-forming ability, direct counts, and direct detection of the xylE gene and phenotypic expression of its product. (Author's abstract)
W90-02786

MICROBIAL DEGRADATION OF SEVEN AMIDES BY SUSPENDED BACTERIAL POPULATIONS.
Environmental Protection Agency, Athens, GA. Southeast Environmental Research Lab.
W. C. Steen, and T. W. Collette.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 10, p 2545-2549, 1989. 4 fig, 1 tab, 12 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Microbiological studies, *Amides, *Microbial degradation, Ponds, Rate constants, Niclosamide, Propachlor, Regression analysis.

Microbial transformation rate constants were determined for seven amides in natural pond water. A second-order mathematical rate expression

served as the model for describing the microbial transformation. Also investigated was the relationship between the infrared spectra and the second-order rate constants for these amides. Second-order rate constants (k2) ranged from a low of 2.0 x 10 to the minus 14th power to a high of 1.1 x 10 to the minus 9th power liters/organism/h for niclosamide (2',5-dichloro-4'-nitrosalicylanilide) and propachlor (2-chloro-N-isopropylacetanilide), respectively. The mechanism of degradation (i.e., microbially mediated hydrolysis) of the amides was consistent with that of other organic chemicals previously studied in a variety of natural waters. Preliminary investigations indicate that temporal variations in measured second-order rate constants are small. A simple linear regression of the infrared carbonyl-stretching frequency with log k2 gave a correlation coefficient (r sq) of 0.962. (Author's abstract)
W90-02787

ANAEROBIC DECHLORINATION OF 2,4-DICHLOROPHENOL IN FRESHWATER SEDIMENTS IN THE PRESENCE OF SULFATE.
Georgia Univ., Athens. Dept. of Microbiology.
G. W. Kohring, X. Zhang, and J. Wiegel.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 10, p 2735-2737, 1989. 3 fig, 16 ref. NSF Grant OCE-84-16384, EPA Grant CR 812638, DOE Grant DE-FG 09-86 13614.

Descriptors: *Fate of pollutants, *Toxic wastes, *Microbial degradation, *Toxins, *Bottom sediments, *Polychlorinated biphenyls, Sulfates, Nitrates, Leaching, Carbon.

Some toxic compounds, especially polychlorinated aromatic compounds, are slowly degraded in polluted aerobic zones and, therefore, may leach into anaerobic subsurface environments. If not degraded there, these compounds will pollute aquifers. Sulfate and nitrate function as electron acceptors in the anaerobic environments; the addition of these anions thus has the potential to alter the carbon flow and the interactions among members of the microbial community. In the presence of added sulfate, 2,4-dichlorophenol and 4-chlorophenol were transformed stoichiometrically to 4-chlorophenol and phenol, respectively, in anaerobic freshwater lake sediments between 18 and 40 degrees C. The concomitantly occurring sulfate reduction reduced the initial sulfate concentration from 25 mM to about 6 to 8 mM and depressed methane formation. Because no organisms which can reductively dechlorinate 2,4-dichlorophenol or 4-chlorophenol have been isolated in pure cultures, it is not known whether the dechlorinations under methanogenic and sulfate-reducing conditions are catalyzed by the same organisms. However, the increased transformation rate for 4-chlorophenol under sulfate-reducing conditions after adaptation under methanogenic conditions indicates that the same organism could be catalyzing the dechlorinations under both conditions. (White-Reimer-PTT)
W90-02791

ANALYSIS OF TRICHLOROETHYLENE MOVEMENT IN GROUNDWATER AT CASTLE AIR FORCE BASE, CALIFORNIA.
Geological Survey, Menlo Park, CA.
L. Avon, and J. D. Bredehoeft.
Journal of Hydrology JHYDA7, Vol. 110, No. 1/2, p 23-50, Sep 1989. 19 fig, 3 tab, 21 ref.

Descriptors: *Organic compounds, *Trichloroethylene, *Groundwater pollution, *Path of pollutants, *California, Model studies, Solute transport, Simulation analysis, Mass balance.

A trichloroethylene (TCE) plume has been identified in the groundwater under a U.S. Air Force Base in the Central Valley of California. An areal, two-dimensional numerical solute transport model indicates that the movement of TCE due to advection, dispersion, and linear sorption is simulated over a 25-year historic period. The model is used in several ways: (1) to estimate the extent of the plume; (2) to confirm the likely sources of contamination as suggested by a soil organic vapor survey of the site; and (3) to make predictions about future

movement of the plume. Despite the noisy and incomplete data set, the model reproduces the general trends in contamination at a number of observation wells. The analysis indicates that soil organic vapor monitoring is an effective tool for identifying contaminant source locations. Leaky sewer pipes and underground tanks are the indicated pathways for TCE to have entered the groundwater system. The chemical mass balance indicates that a total of about 100 gallons of TCE--a relatively small amount of organic solvent--has created the observed groundwater plume. (Author's abstract)
W90-02797

PREFERENTIAL SOLUTE TRANSPORT IN LAYERED HOMOGENEOUS SANDS AS A CONSEQUENCE OF WETTING FRONT INSTABILITY.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
For primary bibliographic entry see Field 2G.
W90-02800

MARINE OUTFALL DESIGN--COMPUTER MODELS FOR INITIAL DILUTION IN A CURRENT.
Memorial Univ. of Newfoundland, St. John's.
J. J. Sharp, and E. Moore.
Proceedings of the Institution of Civil Engineers PCIEAT, Vol. 86, Pt. 1, p 953-961, Oct 1989. 1 fig, 5 tab, 21 ref.

Descriptors: *Ocean outfall, *Wastewater disposal, *Path of pollutants, *Wastewater outfall, Mixing, Mathematical studies, On-site tests, Comparison studies.

When effluent is discharged from a submerged marine outfall it rises to the surface because of buoyancy and is diluted with sea water as it rises. Reasonably accurate means of predicting dilution in still water are available and a number of methods have been proposed for estimating dilution of jets discharged into moving water. The predictions of three mathematical models (UOUTPLM, UDKHDEN, and UMERGE) developed by the United States Environmental Protection Agency are compared with field data collected at outfalls in England. In each of the three models the tendency is to overpredict the amount of dilution that will occur. The discrepancies arise partly because of the difficulties of sampling the most concentrated part of the boil. Problems also arise because of the difficulties of measuring current structures precisely in the field, and financial limitations on field work often preclude detailed information. Some minor errors will be introduced because the models deal generally with discharge parallel to the current whereas cross currents existed at the outfalls studied in the field. The discrepancies between theory and measurement should be of particular concern to designers who must be aware that it is not possible to make definite predictions of moving water dilution. (White-Reimer-PTT)
W90-02808

OCCURRENCE OF DRUG-RESISTANT BACTERIA IN COMMUNAL WELL WATER AROUND PORT HARCOURT, NIGERIA.
D. D. Ibiebele, and T. G. Sokari.
Epidemiology and Infection EPINEU, Vol. 103, No. 1, p 193-202, Aug 1989. 6 tab, 28 ref.

Descriptors: *Pathogenic bacteria, *Antibiotics, *Public health, *Nigeria, Survival, Resistance, Pseudomonas, Klebsiella, Staphylococcus, Proteus, Enterococcus, Aeromonas, Escherichia coli, Chromobacterium, Flavobacterium, Serratia.

A total of 108 raw water samples was collected from 36 wells at nine shanty settlements around Port Harcourt, Nigeria, over a period of 7 months. Samples were analyzed for their bacteriological quality. Selected bacterial strains isolated from the samples were tested for their susceptibility to ten commonly used antibiotics. The organisms isolated include Pseudomonas spp., Klebsiella spp., Staphylococcus spp., Proteus spp., Enterococcus faecalis, Aeromonas spp., Escherichia coli, Chromobacter-

ium spp., Flavobacterium spp., and Serratia spp. Out of 300 strains tested 23 (6.9%) were susceptible to all the antibiotics, 277 (92.3%) were resistant to at least one antibiotic and 232 (77.3%) were resistant to two or more antibiotics. Such levels of resistance would be attributable, at least in part, to the uncontrolled use of antibiotics and the practice of self-medication common in Nigeria. While the use of antibiotics may not cause bacteria to become resistant, the increasing use of the drugs would provide an intense selection pressure in favor of organisms that possess genes coding for drug resistance. (Author's abstract)
W90-02816

CHANGES IN THE COMPOSITION OF RAINWATER UPON PASSAGE THROUGH THE CANOPIES OF TREES AND OF GROUND VEGETATION IN A DUTCH OAK-BIRCH FOREST.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Geology.
E. J. Velthorst, and N. Van Breemen.
Plant and Soil PLSOA2, Vol. 119, No. 1, p 81-85, Sep 1989. 1 fig, 1 tab, 13 ref.

Descriptors: *Acid rain, *Path of pollutants, *Water chemistry, *Chemistry of precipitation, *Throughfall, *Canopy, *The Netherlands, Forests, Nitrogen, Sulfur, Hydrogen ion concentration, Phosphorus, Assimilation, Vegetation.

The composition of canopy throughfall water in an oak-birch woodland, heavily affected by atmospheric deposition of N and S, changed markedly upon contact with the above-ground parts of the ground vegetation, which consisted mainly of bracken. The fluxes of nitrate and H(+) decreased, simultaneously with an increase in the flux of bicarbonate, indicative of above-ground uptake of nitrate by the ground vegetation. This above-ground assimilation takes place in spite of abundant availability of inorganic nitrogen in the root zone of the ground vegetation. Fluxes of phosphate were somewhat lower, and those of ammonium somewhat higher in throughfall of the ground vegetation than in that of the tree layer. Although those differences were not statistically significant, they do suggest assimilation of some P and extra net dry deposition of atmospheric ammonia below the tree canopies. (Author's abstract)
W90-02826

FATE OF FENTHION IN SALT-MARSH ENVIRONMENTS: I. FACTORS AFFECTING BIOTIC AND ABIOTIC DEGRADATION RATES IN WATER AND SEDIMENT.
Environmental Protection Agency, Gulf Breeze, FL. Gulf Breeze Environmental Research Lab.
C. R. Cripe, E. J. O'Neill, M. C. Woods, W. T. Gilliam, and P. H. Pritchard.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 9, p 747-758, 1989. 4 fig, 3 tab, 41 ref. EPA Cooperative Agreement CR-809370; Northrup Services, Inc. Contract 68-03-2134; and Technology Applications, Inc. Contract 68-03-6265.

Descriptors: *Biodegradation, *Fate of pollutants, *Sediments, *Salt marshes, *Insecticides, *Organophosphorus pesticides, Mosquitoes, Marsh plants, Degradation, Products.

Fenthion (Baytex), an organophosphate insecticide, is frequently applied to salt-marsh environments to control mosquitoes. Shake-flask tests were used to study rates of abiotic and biotic degradation of fenthion and the environmental parameters that affect these rates. Water or water-sediment (500 mg dry weight/L) slurries from salt marshes located along the Northwest Florida Gulf Coast were used. Flasks contained 200 micrograms fenthion/L, and degradation rates were determined by following decrease of fenthion over time. Hydrolysis and biodegradation in water were relatively insignificant fate processes. The presence of nonsterile sediment resulted in a rapid exponential disappearance of fenthion (half-life > or = 3.8 d). Biodegradation was assumed since sterile sediment systems showed a much slower decrease of fenthion, and the production of polar compounds

(hexane-unextractable) from radiolabeled fenthion was greater in the presence of sediment than sterilized sediment. The effect of environmental pH levels (5.0-7.0) on degradation was insignificant. No biotic degradation occurred at low oxygen concentration. An 8 degree C decrease in incubation temperature decreased the rate of sediment biodegradation 2.5-fold. Light caused a slight, but significant, increase in the biotic and abiotic degradation rates of fenthion in water. A two-fold variation in degradation was noted among sediment samples from three stations within one field site. Inclusion of whole marsh plants or plant parts increased the disappearance rate of fenthion in test systems. (See also W90-02838) (Author's abstract)
W90-02837

FATE OF FENTHION IN SALT-MARSH ENVIRONMENTS: II. TRANSPORT AND BIODEGRADATION IN MICROCOSMS.
Technical Resources, Inc., Gulf Breeze, FL.
E. J. O'Neill, C. R. Cripe, L. H. Mueller, J. P. Connolly, and P. H. Pritchard.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 9, p 759-768, 1989. 6 fig, 3 tab, 29 ref. EPA Cooperative Agreement CR-809370; Northrop Services, Inc., Contract 68-03-2134; and Technology Applications, Inc., Contract 68-03-6265.

Descriptors: *Biodegradation, *Fate of pollutants, *Sediments, *Salt marshes, *Insecticides, *Organophosphorus pesticides, Growth chambers, Marsh plants, Mathematical models.

The fate of fenthion was examined in laboratory microcosms to describe interaction between sediment and biodegradation in the field. A mathematical model also was calibrated to calculate distribution of fenthion in microcosms. Intact sediment cores, with and without a salt-marsh plant, Juncus roemerianus (black needlerush), were placed in microcosm vessels to simulate an undisturbed sediment bed of a salt marsh and areas containing Juncus. In a formalin-sterilized microcosm without plants, fenthion disappeared exponentially from the water column with a half-life of 105.0 h. Fenthion had a half-life of 35.5 h in a nonsterile microcosm without plants. In the nonsterile microcosm with plants, the half-life was slightly shorter, 33.2 h. The sediment was fractionated into 0.5 cm layers. Fenthion was found at greater sediment depths in nonsterile systems than predicted by diffusion and sorption in the sterile microcosm, possibly because of bioturbation. Distribution of fenthion in sediment was not appreciably different between microcosms with and without plants. Fenthion appeared to be biodegraded in the upper (1 to 7 mm) sediment layers. (See also W90-02837) (Author's abstract)
W90-02838

PHOTOLYSIS OF PICLORAM IN DILUTE AQUEOUS SOLUTION.
Dow Chemical Co., Midland, MI. Agricultural Products Dept.
K. B. Woodburn, D. D. Fontaine, E. L. Bjerke, and G. J. Kallos.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 9, p 769-775, 1989. 4 fig, 1 tab, 11 ref.

Descriptors: *Fate of pollutants, *Photolysis, *Organic acids, *Herbicides, *Aquatic environment, Forest hydrology, Liquid chromatography, Gas chromatography, Mass spectrometry, Carbon radioisotopes.

Picloram is a widely used, effective herbicide for control of woody plants and broad-leaf weeds in pastures, small grains, timberlands, and various rights-of-way. Photolysis is a major route of degradation for this molecule in the aquatic environment. The photolysis of (2,6-C14)pyridine-labeled picloram (4-amino-3,5,6-trichloro-2-pyridine carboxylic acid) was studied at 25 degrees C in sterile, buffered water at pH 7 and in a natural water sample taken from a forest ecosystem. The first-order half-life for picloram photodegradation was the same in both systems, averaging 2.6 d at 25

Group 5B—Sources Of Pollution

degrees C for a 40 degree N latitude location, midsummer time frame. The photolytic decay of picloram in solution produced two major photoproducts. Thermospray liquid chromatography-mass spectrometry (TSP/LC/MS) and gas chromatography/mass spectrometry (GC/MS) in the electron impact and chemical ionization mode were used to elucidate the structures of the photolysis products. The two major C14-labeled photoproducts were conclusively identified through comparison with analytical standards as oxamic acid (C2H3O4N) and 3-oxo-beta-alanine (C3H5O4N). The presence of these compounds as photoproducts indicates that in aqueous solution picloram undergoes photolytic dechlorination and cleavage of the puridine ring system. The exact mechanism of photolytic decay of picloram is not currently known. (Author's abstract)
W90-02839

OCTANOL/WATER PARTITION COEFFICIENTS AND BIOCONCENTRATION FACTORS OF CHLORONITROBENZENES IN RAINBOW TROUT (SALMO GAIRDNERI).
Bayfield Inst., Burlington (Ontario).
A. J. Niimi, H. B. Lee, and G. P. Kissoon.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 9, p 817-823, 1989. 1 fig, 3 tab, 28 ref.

Descriptors: *Structure-activity relationships, *Path of pollutants, *Biological magnification, *Benzenes, *Trout, *Water pollution effects, Organic compounds, Risk assessment, Correlation analysis.

Bioconcentration factor (BCF) has been correlated with the octanol/water partition coefficient (K sub ow) of a chemical to predict the accumulation potential of organic chemicals by fish. Limited information indicates BCF values within some chemical groups do not approach those predicted from K sub ow and BCF relationships derived for fish. BCF values reported for aromatic hydrocarbons and chlorinated dioxins are lower than predicted. The relationship between K sub ow and BCF of 14 monochloro- to pentachloronitrobenzenes were examined in rainbow trout through waterborne and dietary exposure studies. The results indicated BCF was not significantly correlated with K sub ow for this chemical group. The role of chemical half-lives and chemical absorption efficiencies are examined as factors that could explain why the BCF of some chemical groups are lower that predicted. The probable influence of these factors on BCF values does not diminish the importance of its relationship with K sub ow as a hazard assessment procedure. (Author's abstract)
W90-02844

HYDROLOGIC ENVIRONMENTS AND WATER QUALITY CHARACTERISTICS AT FOUR LANDFILLS IN MECKLENBURG COUNTY, NORTH CAROLINA, 1980-86.
Geological Survey, Raleigh, NC. Water Resources Div.
A. P. Cardinell, C. R. Barnes, W. H. Eddins, and R. W. Coble.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4035, July 1989. 79p, 24 fig, 4 tab, 31 ref.

Descriptors: *Urban hydrology, *Groundwater pollution, *Water quality, *Water pollution sources, *Path of pollutants, *North Carolina, *Landfills, *Leachates, Mecklenburg County, Charlotte.

The U.S. Geological Survey initiated an urban water-quality study in 1979 in cooperation with the City of Charlotte and Mecklenburg County, North Carolina, to study the effects of solid waste disposal on the water quality in Mecklenburg County. Water quality samples were collected at 53 monitoring wells and 20 surface-water sites at four landfills from 1980 to 1986. Samples were analyzed to determine the effects of each landfill on groundwater and surface water quality. Increases above background concentration in inorganic constituents were detected in groundwater downgradient

of the landfills, and the increase was generally greatest as proximity to and age of the landfill cells increased. In general, the increases in calcium, magnesium, and chloride concentrations were greater relative to other major ions in downgradient wells, with manganese concentrations exhibiting the largest relative increase in concentrations between upgradient and downgradient wells of any constituent. Differences between upgradient and downgradient concentrations of total organic carbon and specific organic compounds were not as apparent. Chlorofluoromethanes were identified in several groundwater samples analyzed for volatile organic compounds. Landfills affected the water quality of several smaller streams but did not noticeably affect larger ones. Effects on water quality were greatest at the oldest landfill, located on Statesville Road, where current solid-waste management practices were not used, and waste is in cells that are partly below the water table. (USGS)
W90-02847

ANALYTICAL SOLUTIONS FOR ONE-, TWO-, AND THREE-DIMENSIONAL SOLUTE TRANSPORT IN GROUND-WATER SYSTEMS WITH UNIFORM FLOW.
Geological Survey, Miami, FL. Water Resources Div.
E. J. Wexler.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-56, 1989. 250p, 21 fig, 10 tab, 31 ref.

Descriptors: *Path of pollutants, *Solute transport, *Computer programs, *Groundwater movement, Groundwater pollution, Differential equations, Adsorption, Conservative solute transport.

Analytical solutions to the advective-dispersive solute transport equation are useful in predicting the fate of solutes in groundwater. Analytical solutions compiled from available literature or derived by the author are presented in this report for a variety of boundary condition types and solute-source configuration in one-, two-, and three-dimensional systems with uniform groundwater flow. A set of user-oriented computer programs was created to evaluate these solutions and to display the results in tabular and computer-graphics format. These programs incorporate many features that enhance their accuracy, ease of use, and versatility. Documentation for the programs describes their operation and required input data, and presents the results of sample problems. Derivations of select solutions, source codes for the computer programs, and samples of program input and output also are described. (USGS)
W90-02855

SELECTED HYDROLOGIC DATA FOR FOUNDATION CREEK AND MONUMENT CREEK BASINS, EAST-CENTRAL COLORADO.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-02857

STABILITY OF NITRATE-ION IN SIMULATED DEPOSITION SAMPLES USED FOR QUALITY-ASSURANCE ACTIVITIES BY THE U.S. GEOLOGICAL SURVEY.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 5A.
W90-02858

CHLORINATED ORGANIC COMPOUNDS IN GROUNDWATER AT ROOSEVELT FIELD, NASSAU COUNTY, LONG ISLAND, NEW YORK.
Geological Survey, Albany, NY. Water Resources Div.
D. A. V. Eckhardt, and K. A. Pearsall.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 86-4333, 1989. 62p, 11 fig, 8 tab, 38 ref.

Descriptors: *Long Island, *New York, *Geohydrology, *Groundwater pollution, *Organic solvents, Geology, Hydrology, Groundwater, Water quality, Groundwater movement, Pumpage, Artificial recharge, Recharge basins.

Trichloroethylene (TCE), 1,2-dichloroethylene (DCE), and tetrachloroethylene (PCE) have been detected in water from five public-supply wells and six cooling-water wells that tap the Magothy aquifer at Roosevelt Field, a 200-acre area that is now a large shopping mall and office-building complex. The cooling water is discharged after use to the water table (upper glacial) aquifer through a nearby recharge basin and a subsurface drain field. Three plumes of TCE in groundwater have been delineated--the source plume, which has penetrated both aquifers, and two more recent plumes emanating from the two discharge sites in the water-table aquifer. Concentrations of inorganic constituents in the three plumes are the same as those in ambient water in the area. The two secondary plumes discharged cooling water extended at least 1,000 ft south-southeastward in the direction of regional groundwater flow. Pumping at wells screened in the middle and basal sections of the Magothy aquifers, where clay layers are absent and sandy zones provide good vertical hydraulic connection within the aquifer system, has increased the rate of downward contaminant advection. The transient increases in downward movement are cumulative over time and have brought TCE to the bottom of the Magothy aquifer, 500 ft below land surface. (USGS)
W90-02859

RELATION BETWEEN LAND USE AND GROUND-WATER QUALITY IN THE UPPER GLACIAL AQUIFER IN NASSAU AND SUFFOLK COUNTIES, LONG ISLAND, NEW YORK.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 4C.
W90-02861

NATURAL GROUND-WATER QUALITY IN MICHIGAN: 1974-87.
Geological Survey, Lansing, MI. Water Resources Div.
For primary bibliographic entry see Field 2K.
W90-02864

SUPERFUND RECORD OF DECISION: ODESSA CHROMIUM II, TX.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-02917

SUPERFUND RECORD OF DECISION: CENTRAL CITY/CLEAR CREEK, CO.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-02918

CHEMICAL FATE OF BRASS DUST IN WATERS OF VARYING HARDNESS LEVELS.
Chemical Research and Development Center, Aberdeen Proving Ground, MD.
W. T. Muse.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A199 598. Price codes: A03 in paper copy, A01 in microfiche. Report No. CRDEC-TR-88131, August 1988. 28p, 8 fig, 3 tab, 11 ref. CRDEC Project 1L162622.

Descriptors: *Path of pollutants, *Brass, *Fate of pollutants, *Hardness, *Water pollution effects, Chemical reactions, Solubility, Aquatic environment, Copper, Zinc, Toxicity.

The chemical fate of brass dust was examined at four levels of water hardness ranging from very soft to very hard water. The brass dust was added at a concentration of 10 mg to two sets of test

water at each hardness level. In the first set, the brass was applied on the water surface; in the second set, the brass was mixed into the water by sonication. Atomic absorption analysis, conducted over 21 days, to determine the rate of brass breakdown into soluble copper (Cu) and zinc (Zn), disclosed that the greatest dissociation occurred in the very soft water. The percentage of soluble metal dissociated from the brass at other hardness levels was comparable, ranging from 5 to 11% Cu and 6 to 8% for Zn. The effects of mixing the brass into the water accelerated the initial release of soluble Cu and Zn and increased the dissociation of Zn. Any associated toxicity of the brass to aquatic organisms would probably occur soon after the brass entered the aqueous environment. (Author's abstract)
W90-02925

INVESTIGATION OF TRACE METALS IN THE AQUEOUS ENVIRONMENT.
Texas Southern Univ., Houston.
B. Wilson.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-014030. Price codes: A03 in paper copy, A01 in microfiche. Report No. DOE/CH/10255–T1, May 10, 1988. 28p, 3 fig, 9 tab, 8 ref. DOE Contract DE-FG02-86CH10255.

Descriptors: *Fate of pollutants, *Water pollution sources, *Trace metals, *Electric powerplants, Coal wastes, Soil contamination, Lead, Uranium, Radioisotopes, Barium, Cadmium, Copper, Cobalt, Chromium, Iron, Mercury, Manganese, Molybdenum, Titanium, Vanadium, Zinc, Phosphorus, Fly ash, Lake sediments, Sediments.

The two major sources of trace contaminants to the local environment from the combustion and utilization of coal by the electric utility industry are stack gases and fine metallic aerosols not removed by pollution control equipment and the ash residues of the combustion process. The primary purpose of this project was to examine trace metals and radionuclides contents in aqueous (water column and interstitial water of the bottom sediments) and soil samples near a local coal-fired powerplant. In addition to trace elements released from coal-fired powerplants, there is additional release of natural radionuclides upon the combustion of coal. Anthropogenic sources contribute 6.5% of the total 210-Po atmospheric flux. From the continental U.S., fossil fuel burning makes up 14% of these anthropogenic sources of 1% of the total 210-Po input. One can determine a maximum concentration of 210-Po indirectly from the 210-Pb content in the coal, since 210-Pb is the grandparent of 210-Po in the 238-U decay series. The main objectives were the following: (1) to investigate the trace metals which are found in the aqueous environment: Ba, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Pb, Ti, V, and Zn; and (2) to study the natural radionuclides: 40-K, 210-Pb, 228-Th, 228-Ra, 235-U, and 238-U which may be released in the fly ash of coal-fired powerplants or as nuclear test weapon waste products. In all the samples, concentrations of gamma energies 338 KeV (228-Ac daughter product of 232-Th) and 609 keV (214-Bi daughter product of 238-U) were less than the lower limits of detection. All other prominant peaks due to daughter products of 238-U and 232-Th were detected. In three lake sediment sampled, very small concentrations of 137-Cs were found and at depths of only 0-12 cm from the surface. These results clearly indicate, that 137-Cs is being settled recently in the sediment which could be the result of nuclear test weapons. The rest of the results show that the concentrations of 40-K and daughter products of 238-U and 232-Th are slightly higher when close to the surface which probably is due to new releases of nuclides from the powerplant. (Lantz-PTT)
W90-02929

EVALUATING IMPACTS OF POLLUTANTS FROM THE ATMOSPHERE.
Minnesota Univ., St. Paul. Dept. of Soil Science.
D. F. Grigal, and R. S. Turner.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-014550.

Price codes: A03 in paper copy, A01 in microfiche. Report No. CONF-8803128--1, (1988). 26p, 102 ref. EPA Interagency Agreement DW89931594-01-3 and DOE Contract DE-AC05-84OR21400.

Descriptors: *Water pollution sources, *Soil contamination, *Acid rain effects, *Air pollution effects, Aluminum, Hydrogen ion concentration, Sulfates, Lead, Mercury, Mathematical models, Chemical analysis, Mathematical models.

As a result of industrialization, concentrations of many compounds have increased in the atmosphere. Deposition of some of these compounds from the atmosphere to soil has been hypothesized to alter soil properties. Those alterations may adversely affect plant growth and create conditions for movement of toxic materials from terrestrial to aquatic ecosystems. Acidic deposition, in both wet and dry forms, can displace and hence remove nutrient cations from the rooting zone. Associated declines in pH can increase the solubility of toxic metals such as Al. In acid soils, increasing SO4(2+) concentrations in soil solution from atmospheric deposition can also mobilize Al. Atmospheric deposition can also increase the concentration of other toxic metals, such as Pb and Hg, in soil. Assessment of the impacts of deposition on soil may depend on before-and-after sampling, whereby results of recent analyses are compared to results either from older reports or from reanalysis of archived samples. Assessment of impacts can also be made by field measurements of soil solution chemistry or by measurements of changes in soil chemical properties. Mathematical models have been developed to predict the chemistry of soil solution or the chemistry of soil with varying levels of deposition over time. These models require greater precision in the measurement of some parameters that are routinely used to characterize soils, and they often require additional parameters that are not routinely measured. Examples of some of these parameters are SO4(2+) adsorption isotherms, unbuffered exchange acidity, and weathering rates. Because of the high cost associated with the characterization of soils, decisions about sampling procedures are difficult. A rigorous statistical approach often leads to under-representation or even lack of representation of many minor soil units. Because of their spatial relationships on the landscape, these units may be very important in affecting the movement of materials to aquatic systems. The alternative sampling approach, based on field experience and judgment, leads to difficulties in extrapolation because of its subjectivity and to problems in convincing naive users of its worth. (Lantz-PTT)
W90-02934

TRACE METAL STUDY OF AQUEOUS SEDIMENTS SURROUNDING A COAL-FIRED ELECTRIC GENERATING FACILITY.
Texas Southern Univ., Houston. Dept. of Chemistry.
B. L. Wilson, and D. L. Mitchell.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-014918. Price codes: A03 in paper copy, A01 in microfiche. Report No. CONF-870436--2, (1987). Presented at the 14th Annual National Conference of the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers, April 13-18, 1981, Hotel Meridien, San Francisco, California.

Descriptors: *Water pollution sources, *Trace metals, *Coal wastes, *Electric powerplants, *Path of pollutants, *Air pollution, Fly ash, Sediment contamination, Carcinogens, Mercury, Lead,, Vanadium, Zinc, Heavy metals.

There are approximately 1300 coal-fired facilities that generate > 55% of the nation's electricity. State-of-the-art technology removes 99% of the particulates in coal and 97% of the SO2. That kind of efficiency appears to be more than adequate until one realizes that the coal consumption of some power generating facilities may exceed 15,000 tons/day. The potential anthropogenic effects of a daily release of pollutants to the environment via stack gases, fine metallic aerosols (which elude modern pollution control equipment), and fly

ash, then becomes obvious. The aqueous sediments of several lakes surrounding a coal-fired electric generating facility in southwest Houston were analyzed for trace metals by atomic absorption spectroscopy. Twenty to twenty-five centimeter cores were treated and analyzed for carbon content, sediment size, and trace metal concentration. A higher concentration was present in the top portion of some cores, which suggests that there may have been some contribution to the aqueous sediment due to the recent industrialization of southwest Houston. The elements of concern in this study are some that are known to have a carcinogenic and/or mutagenic effect on man, such as Hg, Pb, V, and Zn. Furthermore, the significance of this study is immeasurable in that it establishes background data that is critical in substantiating any claims of future additions and in preventing any potential health hazards in lake and stream eutrophication. (Author's abstract)
W90-02935

RCRA (RESOURCE CONSERVATION AND RECOVERY ACT) FACILITY INVESTIGATION (RFI) GUIDANCE. VOLUME 3: AIR AND SURFACE WATER RELEASES.
NUS Corp., Gaithersburg, MD.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-128573. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA-530/SW-87-001C, July 1987. 215p, 9 fig, 23 tab, 79 ref, append. EPA Contracts 68-01-7310 and 68-01-6871.

Descriptors: *Path of pollutants, *Water pollution sources, *Water pollution control, *Air pollution, *Hazardous wastes, *Resource Conservation and Recovery Act, *Management planning, *Superfund, *Surface water, Water pollution, Field tests.

The objective of an investigation of a release to air is to characterize the nature, extent, and rate of migration of the release of hazardous waste or constituents to that medium. This is done by characterizing long-term ambient air concentration associated with unit releases of hazardous wastes or constituents to air. The first section of the report provides: a recommended strategy for characterizing releases to air, which includes characterization of the source and the environmental setting of the release, and conducting a monitoring and/or modeling program which will characterize the release itself; recommendations for data organization and presentation; field methods which may be used in the investigation; and a checklist of information that may be needed for release characterization. The second part investigates a release to surface water, and characterizes the nature, extent, and rate of migration of the release to this medium. This section provides the following: an overall strategy for characterizing releases to the surface water system (e.g., water column, bottom sediments, and biota), which includes characterization of the source and the environmental setting of the release, and conducting a monitoring program that will characterize the release; a discussion of waste and unit source characteristics and operative release mechanisms; a strategy for the design and conduct of monitoring programs considering specific requirements of different wastes, release characteristics, and receiving water bodies; recommendations for data organization and presentation; appropriate field and other methods that may be used in the investigation; and a checklist of information that may be needed for release characterization. (Lantz-PTT)
W90-02936

DEVELOPMENT, TESTING, AND VERIFICATION OF AN OIL SPILL SURF-ZONE MASS-TRANSPORT MODEL.
Coastal Science and Engineering, Inc., Columbia, SC.
M. Reed, T. W. Kana, and E. R. Gundlach.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-118616. Price codes: A14 in paper copy, A01 in microfiche. Report No. OCS/MMS-88/0032, June 1988. 298p, 49 fig, 31 tab, 110 ref, 2 append. Contract DI-14-12-0001-30130.

Descriptors: *Oil spills, *Path of pollutants, *Model studies, Surf, Fate of pollutants, Alaska, Computer models, Simulation analysis, Shores, Oil pollution, Viscosity, Mathematical models.

Phase II of a multi-year project to develop and test a probabilistic coastal zone oil spill (COZOIL) model for use by the Minerals Management Service is described. The report is divided into sections covering description of model algorithms, description and results of field surveys at a test site along Bristol Bay Alaska, flexibility of the model to implement various input data and user options, results of model tests for waves in the field study area, and results of model tests using prototype data from the Amoco Cadiz oil spill. The purpose of the project was to develop a generic, computer-based model for the simulation of oil spills entering the surf zone, impacting a shoreline, and transforming through time as a result of physical and chemical processes. COZOIL, therefore, builds on previous oil spill trajectory and fates models which typically end with contact at the coastline. The present model includes explicit representations of as many known, active processes as possible, partitioning oil quantities among air, water surface, water column and the substrate/groundwater systems in or near the surf zone. The model outputs include boiling-point-cut information, overall mass balance, and line plots showing the location of surface and alongshore oil distribution. Stochastic oil-distribution estimates are produced by combining the results of multiple simulations using a statistical analysis processor at the end of a test. COZOIL was tested against prototype data for wave predictions using the Bristol Bay field data (Port Heiden) obtained by the study team in August-September 1987. Results indicate the model produces realistic approximations of wave height, wave period, and approach angle from a local or offshore wind field. The detailed, mesoscale test case generally overestimated the quantity of oil onshore, but produced the general variance and distribution of oil. The macroscale test cases provided less resolution because of grid cell size, but reproduced the overall distribution of offshore and onshore oil quite well. (Lantz-PTT)
W90-02937

VECTORIZED PROGRAMMING ISSUES FOR FE MODELS.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
For primary bibliographic entry see Field 7C.
W90-02982

PARAMETER IDENTIFICATION AND UNCERTAINTY ANALYSIS FOR VARIABLY SATURATED FLOW.
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W90-02983

MODELING OF HIGHLY ADVECTIVE FLOW PROBLEMS.
Rice Univ., Houston, TX. Dept. of Mathematical Sciences.
For primary bibliographic entry see Field 7C.
W90-02984

ALTERNATING DIRECTION GALERKIN METHOD COMBINED WITH CHARACTERISTIC TECHNIQUE FOR MODELLING OF SATURATED-UNSATURATED SOLUTE TRANSPORT.
Fuzhou Univ. (China). Dept. of Geology and Mining Engineering.
For primary bibliographic entry see Field 2F.
W90-02996

NUMERICAL SIMULATION OF DIFFUSION RATE OF CRUDE OIL PARTICLES INTO WAVE PASSES WATER REGIME.
Rivers State Univ. of Science and Technology, Port Harcourt (Nigeria). Dept. of Chemical and Petrochemical Engineering.

M. F. N. Abowei.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 141-146, 1 fig, 3 tab, 6 ref.

Descriptors: *Path of pollutants, *Model studies, *Nigeria, *Oil spills, *Diffusion, *Numerical analysis, *Wind waves, Mathematical models, Simulation, Computer programs, Oil, Prediction, Fate of pollutants.

The mechanism of dispersion of organic compounds in water has been investigated by various authors. But there were no realistic mathematical models that correlate the physical properties of oil, wave dimensions, and diffusion coefficient. Numerical models were developed to simulate the diffusion rate of crude oil particles in a laboratory wind/wave tank. The models were used to correlate the diffusion rate as a function of the physical properties of the crude oil sample, wave dimensions, and diffusion coefficient. Input data for the models were obtained from studies with a laboratory wind-wave tank using samples of Nigerian crude oil (Aran, Adibawa, Apara, Obigbo). The models were simulated with a Hewlett-Packard HP-85 computer and it was shown that the diffusion rate was influenced mainly by the crude oil density and wave phase differences. The models are useful in predicting the extent of crude oil diffusion as a result of oil spillage. (See also W90-02980) (Author's abstract)
W90-03000

DECOUPLED APPROACH TO THE SIMULATION OF FLOW AND TRANSPORT OF NON-AQUEOUS ORGANIC PHASE CONTAMINANTS THROUGH POROUS MEDIA.
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
H. W. Reeves, and L. M. Abriola.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 147-152, 11 ref. NSF Grant ECE-8451469.

Descriptors: *Path of pollutants, *Porous media, *Soil contamination, *Groundwater movement, *Model studies, *Groundwater pollution, Simulation, Solute transport, Oil, Propane, Infiltration, Chemical equations, Mathematical models, Numerical analysis, Organic compounds.

A decoupled approach to the simulation of simultaneous flow and transport in porous media is presented. A sample problem illustrates the application of this technique to the case of an infiltrating contaminant. In this problem, an organic mixture consisting of a heavy oil and propane infiltrate a soil column with a residual water content. The partitioning of propane between the phases is described by a saturation-dependent equation with constant molar partition coefficients. Using the decoupled approach, additional species may be considered by increasing the number of transport equations. The flow equations are not changed. The chemical expressions that define the relationships between mass fractions in each phase appear only in the transport equations. This formulation of the mass balance equations allows these expressions to be changed conveniently without major revision to the rest of the numerical model. The increased flexibility makes the decoupled technique desirable and the smaller matrix equations resulting from this formulation lead to a more efficient numerical model. (See also W90-02980) (Rochester-PTT)
W90-03001

TRANSITION POTENTIALS DEFINING THE FLOW BOUNDARIES IN MULTIPHASE POROUS MEDIA FLOW.
SIMULTEC A.G., Zurich (Switzerland).
For primary bibliographic entry see Field 2F.
W90-03002

ENHANCED PERCOLATION MODEL FOR THE CAPILLARY PRESSURE-SATURATION RELATION.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2G.
W90-03003

SOLVING STOCHASTIC GROUNDWATER PROBLEMS USING SENSITIVITY THEORY AND HERMITE INTERPOLATING POLYNOMIALS.
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
For primary bibliographic entry see Field 2F.
W90-03005

COMPARISON OF NUMERICAL SOLUTION TECHNIQUES FOR THE STOCHASTIC ANALYSIS OF NONSTATIONARY, TRANSIENT, SUBSURFACE MASS TRANSPORT.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-03007

MODELLING OF SEA WATER INTRUSION OF LAYERED COASTAL AQUIFER.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
For primary bibliographic entry see Field 2F.
W90-03009

COMPARISON OF COUPLED FRESHWATER-SALTWATER SHARP-INTERFACE AND CONVECTIVE-DISPERSIVE MODELS OF SALTWATER INTRUSION IN A LAYERED AQUIFER SYSTEM.
Geological Survey, Lakewood, CO.
For primary bibliographic entry see Field 2F.
W90-03010

CAN THE SHARP INTERFACE SALT-WATER MODEL CAPTURE TRANSIENT BEHAVIOR.
Princeton Univ., NJ. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-03011

COMPUTATIONAL METHODS IN WATER RESOURCES, VOL.2: NUMERICAL METHODS FOR TRANSPORT AND HYDROLOGIC PROCESSES.
For primary bibliographic entry see Field 2A.
W90-03036

STABILITY ANALYSIS OF DISCRETE APPROXIMATIONS OF THE ADVECTION-DIFFUSION EQUATION THROUGH THE USE OF AN ORDINARY DIFFERENTIAL EQUATION ANALOGY.
Mexican Inst. of Water Technology, Jiutepec.
For primary bibliographic entry see Field 2F.
W90-03037

FINITE ELEMENT TECHNIQUES FOR CONVECTIVE-DISPERSIVE TRANSPORT IN POROUS MEDIA.
Wyoming Univ., Laramie. Dept. of Mathematics.
For primary bibliographic entry see Field 2F.
W90-03041

3-D FINITE ELEMENT TRANSPORT MODELS BY UPWIND PRECONDITIONED CONJUGATE GRADIENTS.
Padua Univ. (Italy). Inst. of Applied Mathematics.

G. Pini, G. Gambolati, and G. Galeati.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 35-43, 7 fig, 18 ref.

Descriptors: *Path of pollutants, *Mathematical studies, *Solute transport, *Groundwater movement, *Dispersion, *Convection, *Mathematical equations, Galerkin method, Groundwater pollution, Comparison studies, Mathematical models, Test functions, Performance evaluation, Numerical analysis.

Numerical solutions to the dispersion-convection equation in subsurface systems have relied extensively on the Galerkin approach mainly because of its high versatility in handling irregular geometries. However, in convection-dominated problems this approach leads to (1) unstable solutions with oscillating behavior and (2) artificial dispersion, which yields the smearing of the simulated contaminant plume. A class of iterative solvers based on the preconditioned conjugate gradients, and which proved quite robust and efficient in two-dimensional dispersion-convection models, is extended to three-dimensional problems. The performance of the ORTHOMIN(k), the Generalized Conjugate Residual GCR(K), and the Minimum Residual (MR), the convergence of which is conveniently accelerated by appropriate preconditioned matrices, were implemented and analyzed. New asymmetric test functions designed especially for tetrahedral elements were developed for the three-dimensional meshes generated automatically from a two-dimensional triangular mesh. The convergence of the upwind preconditioned solvers is quite good and a solution can be obtained when a failure to converge occurs with the standard Galerkin approach. The ORTHOMIN(k), GCR(k), and MR schemes allow for the easy treatment of a large number of nodes, i.e., for an effective limitation of the numerical dispersion by control of the magnitude of the Peclet and Courant numbers. (See also W90-03036) (Rochester-PTT)
W90-03042

STRUCTURE OF MASS-RESPONSE FUNCTIONS OF DISSOLVED SPECIES IN HYDROLOGIC TRANSPORT VOLUMES.
Trento Univ. (Italy). Dept. of Engineering.
A. Rinaldo, A. Bellin, and A. Marani.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 45-50, 3 fig, 6 ref.

Descriptors: *Path of pollutants, *Mathematical studies, *Japan, *Solute transport, *Stochastic models, *Groundwater movement, Runoff, Soil water, Mass-response functions, Ai River Basin, Numerical analysis, Mathematical models, Nitrates, Mathematical equations.

Field solute transport of reactive solute species is investigated through a class of stochastic models, termed mass-response functions (MRFs), which constitute a new and interesting way of solving large-scale transport problems. A brief description of the major theoretical constraints and strengths implied by the computational schemes is given and a complete modeling example is presented with reference to the basinwide circulation of solutes. The theoretical results were compared with data collected in an experimental watershed in Japan (Ai River basin) which yields a unique reference for this approach to the accuracy of the experimental procedures and the refinement of the sampling procedures using nitrate-N. The computation is explored of the instantaneous fraction of mass sorbed by the solid matrix of the transport volume, which governs the instantaneous equilibrium concentration with the mobile phase. The procedure leads to a first-order integral equation that is solved via an O(delta t squared) scheme. MRFs of solute response in hydrologic transport volumes were examined with reference to the computational structure of the models for practical applications. The present set of examples demonstrated the flexibility and soundness of the theoretical assumptions. (See also W90-03036) (Rochester-PTT)
W90-03043

ADVECTION CONTROL METHOD FOR THE SOLUTION OF ADVECTION-DISPERSION EQUATIONS.
Shandong Univ., Jinan (China).
For primary bibliographic entry see Field 2F.
W90-03044

NON-DIFFUSIVE N+2 DEGREE UPWINDING METHODS FOR THE FINITE ELEMENT SOLUTION OF THE TIME DEPENDENT TRANSPORT EQUATION.
Texas A and M Univ., College Station. Dept. of Civil Engineering.
J. J. Westerink, M. E. Cantekin, and D. Shea.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 57-62, 4 fig, 5 ref. NSF Grant EET-8718436.

Descriptors: *Mathematical studies, *Path of pollutants, *Solute transport, *Groundwater movement, *Finite element method, *Convection, *Diffusion, Mathematical equations, Upwinding methods, Numerical analysis, Performance evaluation, Time series analysis, Spatial distribution, Errors.

The use of standard central type numerical schemes to solve the convection-diffusion equation for convection-dominated flows typically results in solutions that exhibit severe spurious oscillations, as well as damping and phase lag of the fundamental solution. The use of upwinding methods has been a very popular remedy in both finite difference (FD) and finite element (FE) methods. While traditional upwinding methods work well for steady state problems, they lead to over-diffusive solutions for time-dependent problems. A technique is examined that uses upwind weighting functions that are modified by functions two polynomial degrees greater than the basis functions. A quartic biased weighting function is used with quadratic elements. The use and behavior of N+2 degree upwind biased weighting functions (where N equals the degree of the basis function) is detailed here and it is demonstrated that the use of these functions leads to excellent solutions with no numerical diffusion. While N+1 upwinding attempts to eliminate wiggles by adding artificial diffusion (for linear elements) or leads to unstable solutions (for quadratic elements), N+2 upwinding dramatically improves the computed solutions without being over-diffusive. Truncation error analysis shows that N+2 upwinding eliminates both time and space truncation errors. The effectiveness of this capability increases with increasing Courant number (C). For linear elements at low C, N+2 (cubic) upwinding does not entirely eliminate the spatial discretization problems and some smaller wiggles remain. The solution improves dramatically and the wiggles are eliminated as C increases. Quadratic interpolation at low C values is able to effectively handle the spatial discretization and N+2 (quartic) upwinding only slightly enhances the already very good standard solution. (See also W90-03036) (Rochester-PTT)
W90-03045

CHARACTERISTIC ALTERNATING DIRECTION IMPLICIT SCHEME FOR THE ADVECTION-DISPERSION EQUATION.
Nanjing Univ. (China). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-03046

ZOOMABLE AND ADAPTABLE HIDDEN FINE-MESH APPROACH TO SOLVING ADVECTION-DISPERSION EQUATIONS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 2F.
W90-03047

TURBULENT DIFFUSION SIMULATION BY IMPLICIT FACTORED SOLVER USING K-EPSILON MODEL.
Florence Univ. (Italy). Dept. of Energy Engineering.
F. Martelli, and V. Michelassi.
IN: Computational Methods in Water Resources,

Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 95-101, 7 fig, 8 ref.

Descriptors: *Mathematical studies, *Turbulent flow, *Diffusion, *Solute transport, *Open-channel flow, *Path of pollutants, Navier-Stokes equations, Mathematical equations, Stability analysis.

An implicit finite difference procedure for steady two-dimensional incompressible flows with the presence of a pollutant is described. Arbitrary geometries can be solved by implementation of a curvilinear mesh. Turbulence effects are included by means of the Chien version of the K-epsilon model, coupled with Reynolds-averaged Navier-Stokes equations. The artificial compressibility equation of Chorin is used to enforce mass conservation. The implicit approximate factorization of Beam and Warming, specifically extended to cope with the kappa-epsilon nonlinear source terms, is employed to avoid stringent stability limitations. Tests are performed for a straight channel and for a channel with a subsurface mound (hill) for various Reynolds numbers, first solving the mean flow equations coupled with the turbulence models, whereas the pollutant concentration profiles are computed solving a standard transport equation. (See also W90-03036) (Author's abstract)
W90-03051

ADVANCES ON THE NUMERICAL SIMULATION OF STEEP FRONTS.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Geofisica.
For primary bibliographic entry see Field 2F.
W90-03056

THREE-DIMENSIONAL ADAPTIVE EULERIAN-LAGRANGIAN FINITE ELEMENT METHOD FOR ADVECTION-DISPERSION.
Nebraska Univ., Lincoln. Conservation and Survey Div.
For primary bibliographic entry see Field 2F.
W90-03062

COMPUTER MODELING OF GROUNDWATER FLOW THROUGH POROUS MEDIA USING A MONTE-CARLO SIMULATION TECHNIQUE.
TGG Environmental, Inc., Needham, MA.
For primary bibliographic entry see Field 2F.
W90-03063

DISPERSION OF CONTAMINANTS IN SATURATED POROUS MEDIA: VALIDATION OF A FINITE-ELEMENT MODEL.
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
G. L. Moltyaner.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 201-206, 1 fig, 4 ref.

Descriptors: *Mathematical studies, *Model studies, *Groundwater movement, *Solute transport, *Path of pollutants, *Finite element method, *Mathematical models, Nuclear powerplants, Chalk River, Twin Lake aquifer, Isotopic tracers, Computers, Plumes, Iodine radioisotopes, Monitoring wells, Advection, Dispersion.

Experimental and theoretical investigations were performed in an attempt to validate the applicability of finite element-based numerical models for the prediction of the behavior of a conservative tracer (radioiodine) at the Twin Lake aquifer, Chalk River Nuclear Laboratories, Chalk River, Ontario. Three quarter million data points were obtained at the site from a natural gradient tracer test in which tracer was injected into a fully-penetrating well and monitored over 40 m distance over a period of 45 days in a network of 82 boreholes. An advection-dispersion model of radioiodine transport was developed and its equation solved by the standard Galerkin finite element method. The developed coarse-mesh (460 nodes,

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830 elements) finite-element model of radioiodine transport poorly describes the overall behavior of the tracer plume and lacks the capability to simulate fingerlike spreading of the plume because the grid lacks an adequately fine space discretization. A refinement of the grid spacing (7128 nodes, 13,920 elements) significantly improved the simulation. For the advection-diffusion transport, as that encountered at the Twin Lake aquifer, the failure to satisfy the fine mesh requirement causes numerical dispersion. The conventional finite-element model may produce accurate simulation of the tracer cloud, provided that an adequately fine space discretization of the grid compatible with the support scale of the measurements and an adequately fine time discretization are made. This demands large computing resources. (See also W90-03036) (Author's abstract)
W90-03064

MODELING WATER AND CONTAMINANT TRANSPORT IN UNCONFINED AQUIFERS.
Australian Nuclear Science and Technology Organisation, Sutherland. Environmental Science Div.
G. Pantelis.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 207-211, 1 fig, 5 ref.

Descriptors: *Mathematical studies, *Mathematical models, *Groundwater movement, *Solute transport, *Path of pollutants, *Finite element method, Computer programs, Mathematical equations, Convection, Dispersion.

Many computer programs are available for investigating saturated-unsaturated water flow in porous media. Most are based on a Galerkin finite-element method. The use of these computer codes to simulate long-time, three-dimensional water transport in unconfined aquifers can take so much time as to make their use impractical. This is largely because, even under homogeneous and isotropic conditions, the equations describing the flow in the unsaturated zone are highly nonlinear. Simpler models that retain much of the complexity and detail of the problem would be desirable. It is demonstrated that, for the long time scale, the system governing saturated-unsaturated flow in unconfined aquifers can be reduced, in the first approximation, to the single parabolic equation. In the limit of decreasing capillarity this reduces to the Boussinesq equation, which is used to describe only saturated flow and in which the water table is treated as a free surface. Approximation of the specific discharge field and the convection-dispersion equation are considered in relation to the problem of the long time scale case. A procedure is suggested that eliminates the need to obtain the longitudinal dispersivity, a parameter that often is difficult to measure in the field. (See also W90-03036) (Rochester-PTT)
W90-03065

ACCURATE FINE-GRID SIMULATIONS TO DERIVE COARSE-GRID MODELS OF FINE-SCALE HETEROGENEITIES IN POROUS MEDIA.
Colorado Univ. at Denver. Dept. of Mathematics.
For primary bibliographic entry see Field 2F.
W90-03066

NUMERICAL EXPERIMENT WITH EULER-LAGRANGE METHOD FOR A PAIR OF RE-CHARGE-PUMPING WELLS.
Technion - Israel Inst. of Tech., Haifa. Faculty of Bio-Medical Engineering.
S. Sorek.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 219-226, 3 fig, 1 tab, 10 ref.

Descriptors: *Mathematical studies, *Model studies, *Tracers, *Groundwater movement, *Advection, *Dispersion, *Solute transport, *Path of pollutants, *Numerical analysis, Performance evaluation, Computer programs, Wells, Euler-Lagrange Methods, Errors.

The Euler-Lagrange (EL) method is used to numerically solve the transport problem of a pair of recharge-pumping wells. For the sake of comparison with a different numerical scheme, physical parameters (eg, Peclet numbers of approximately 18 near the injection well) and discretization data (refined rectangle elements at the wells' locations) are kept the same. The EL method was developed to rigorously decompose the transport problem into advective and dispersive (residual) problems. The EL scheme deploys at each time step rays of particles commencing from the injection well and carrying the advective part of the concentration. It is demonstrated how to incorporate an additional velocity term into the Lagrangian scheme. The EL method proves to be converging consistently and to be superior in less deviation from the analytical solution, together with higher Courant numbers (i.e., CPU efficiency). (See also W90-03036) (Rochester-PTT)
W90-03067

USE OF PARTICLE TRACKING METHODS FOR SOLUTE TRANSPORT IN POROUS MEDIA.
Lawrence Livermore National Lab., CA. Earth Sciences Dept.
A. F. B. Tompson, and D. E. Dougherty.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 227-232, 1 fig, 24 ref.

Descriptors: *Mathematical studies, *Groundwater movement, *Solute transport, *Path of pollutants, *Numerical analysis, *Dispersion, *Advection, Performance evaluation, Computer programs, Hydrodynamics, Chemical reactions, Diffusion, Coastal aquifers, Wastewater disposal.

The numerical solution of the advection-diffusion (-reaction) equation in any of its forms remains the objective of much research after decades of work. The application of particle methods for the solution of this equation is reviewed and advantages, disadvantages, and difficulties of using the technique are considered. Implementation and application issues of the random walk step equation also are discussed. Two example applications are described: (1) analysis of the dispersive behavior of an expanding solute plume in a synthetic, heterogeneous hydraulic conductivity distribution on a 51 x 51 x 51 rectilinear grid and (2) to examination of the large-scale, chemical (not hydrodynamic) dispersion effects in a study of the effects of heterogeneous adsorption in an otherwise homogeneous porous medium. Future directions in the area of particle transport models are treatment of reactions and multicomponent chemical problems and modeling concentration-dependent flow, as occurs in coastal aquifers and waste storage in briny formations. (See also W90-03036) (Rochester-PTT)
W90-03068

SOLUTION OF SATURATED-UNSATURATED FLOW BY FINITE ELEMENT OR FINITE DIFFERENCE METHODS COMBINED WITH CHARACTERISTIC TECHNIQUE.
Fuzhou Geological Coll. (China).
For primary bibliographic entry see Field 2F.
W90-03070

FINITE ELEMENT SIMULATION OF NITROGEN TRANSFORMATION AND TRANSPORT DURING HYSTERETIC FLOW WITH AIR ENTRAPMENT.
Virginia Polytechnic Inst. and State Univ., Blacksburg.
J. J. Kaluarachchi, and J. C. Parker.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 247-253, 6 fig, 7 ref.

Descriptors: *Mathematical studies, *Model studies, *Solute transport, *Soil contamination, *Path of pollutants, Mathematical models, Air-water interfaces, Finite element method, Hysteresis, Simulation, Nitrogen, Prediction.

A two-dimensional finite element model was used to predict multispecies transport and transformation of nitrogen accompanying unsaturated flow with hysteresis and air entrapment. Results show that, under potential-type boundary conditions, hysteresis influences substantially the transport predictions, largely due to air entrapment effects. Nonhysteretic simulations using main wetting curve parameters corresponded much more closely to hysteretic results than those using main drainage relations. For contaminant introduction via buried line sources of constant strength, hysteresis had little effect on predictions of N transport. (See also W90-03036) (Author's abstract)
W90-03071

CHARACTERISTIC FINITE ELEMENT MODEL FOR SOLUTE TRANSPORT IN SATURATED-UNSATURATED SOIL.
Wuhan Inst. of Hydraulic and Electric Power Engineering (China). Dept. of Irrigation and Drainage.
J. Z. Yang, and W. Z. Zhang.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 255-260, 5 fig, 2 tab, 4 ref.

Descriptors: *Mathematical studies, *Path of pollutants, *Saturated flow, *Unsaturated flow, *Groundwater movement, *Solute transport, *Finite element method, Method of characteristics, Mathematical equations, Simulation, Numerical analysis, Performance evaluation.

A characteristic finite element method is proposed to solve the convection-dispersion equation accounting for mobile and immobile water. The mathematical model employs a moving and deforming coordinate system and is free of numerical dispersion and oscillation. The suggested method has been used to simulate a two-dimensional solute transport experiment. The agreement between calculated and experimental results is generally good. (See also W90-03036) (Author's abstract)
W90-03072

SOLUTE TRANSPORT: EQUILIBRIUM VS NON-EQUILIBRIUM MODELS.
Pontificia Univ. Catolica de Chile, Santiago. Faculty of Engineering.
For primary bibliographic entry see Field 2G.
W90-03073

CONFRONTATIONS BETWEEN COMPUTER SIMULATIONS AND LABORATORY WORK TO UNDERSTAND MECHANISMS CONTROLLING TRANSPORT OF MERCURY.
Strasbourg-1 Univ. (France). Inst. de Mechanique des Fluides.
P. Behra.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 269-274, 4 fig, 1 tab, 9 ref.

Descriptors: *Advection, *Dispersion, *Mathematical studies, *Solute transport, *Path of pollutants, *Groundwater movement, *Mercury, Simulation, Computer models, Performance evaluation, Equilibrium, Mercuric nitrate, Heavy metals, Mercuric chloride.

It is shown how confrontations between computed simulations and discriminating laboratory work allow the development of modelling by validating the assumed concepts. This process represents a step towards a better knowledge of the mechanisms of interactions that occur during the exchanges between liquid and solid phases. The theory describing one-dimensional, advective-dispersive transport of metal micropollutants is reviewed and experimental and simulated results are compared for mercuric chloride and mercuric nitrate exchange in sand columns. Reasons for the failure of simulated breakthrough curves to agree with experimental curves are discussed. It appears that it is necessary to extend the surface complexation concept, that the local equilibrium assumption

cannot be assumed, and that the metal uptake is due to several kinds of surface sites with different transfer rates. (See also W90-03036) (Rochester-PTT)
W90-03074

QUICK ALGORITHM FOR THE DEAD-END PORE CONCEPT FOR MODELING LARGE-SCALE PROPAGATION PROCESSES IN GROUNDWATER.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
H. M. Leismann, B. Herrling, and V. Krenn.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 275-280, 3 fig, 4 ref. German Research Community (DFG) Grant Th 159/14.

Descriptors: *Mathematical studies, *Solute transport, *Groundwater movement, *Path of pollutants, Algorithms, Computer programs, Performance evaluation, Large-scale systems.

The spreading of contaminants in groundwater where immobile and mobile water both interact with the pollutant has been addressed by the mathematical model proposed in 1964 by Coats and Smith. The model uses a second unknown, the concentration of the immobile water, and a simple linear approach for the diffusive exchange. Although the model has been used successfully for one-dimensional modeling of break-through curves found in laboratory soil columns, it rarely has been applied to large-scale models. This is because two unknowns per node must be computed, increasing the computation effort considerably. A method is described to reduce the additional computational effort to almost nil by computation in two steps. This enables the model of Coats and Smith to be applied without disadvantage to the calculation of large-scale propagation. (See also W90-03036) (Rochester-PTT)
W90-03075

SIMULATION OF GROUNDWATER TRANSPORT TAKING INTO ACCOUNT THERMO-DYNAMICAL REACTIONS.
Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl fuer Hydrogeologie und Hydrochemie.
B. J. Merkel, J. Grossmann, and A. Faust.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 281-286, 1 fig, 7 ref.

Descriptors: *Mathematical studies, *Model studies, *Solute transport, *Groundwater movement, *Thermodynamics, *Hydraulic models, *Path of pollutants, *Mathematical models, *Convection, *Dispersion, Method of characteristics, Random walk method, Mathematical equations, Chemical reactions, Saline water, Simulation, Deicers, Suburban areas.

A groundwater transport simulation concept is given that can solve two-dimensional transport problems, taking into account thermodynamic reactions. The computation of groundwater flow is separated totally from transport simulation. Problems where density differences are not significant cannot be solved with this approach. Flow and transport simulation may work on the same spatial grid, but can operate as well on different grids. Convection and dispersion are calculated using a combination of random walk and methods of characteristics. A set of nonlinear mass balance equations can be solved using the Gauss-Seidel technique, or for more equations or equations that describe solution, precipitation, and redox reactions, a modified Newton-Raphson technique. The transport and reaction model was applied the simulation of the effects of salt spreading during winter from a public road service and private activities in a suburb of Munich, West Germany. (See also W90-03036)(Rochester-PTT)
W90-03076

MULTICOMPONENT SOLUTE TRANSPORT WITH MOVING PRECIPITATION/DISSOLUTION BOUNDARIES.

Notre Dame Univ., IN. Dept. of Civil Engineering.
J. A. Mundell, and D. J. Kirkner.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 287-292, 3 fig, 8 ref.

Descriptors: *Mathematical studies, *Model studies, *Solute transport, *Groundwater movement, *Thermodynamics, *Path of pollutants, Mathematical models, Precipitation, Dissolution, Numerical analysis, Differential equations, Chemical reactions, Simulation, Performance evaluation, Comparison studies.

Fixed-mesh finite element enthalpy-type (ET) and front-tracking (FT) formulations were developed for solving precipitation/dissolution chemical transport problems and their performances were compared. These schemes result from particular forms of the weak variation statement of the governing differential equations. Simulations for one-component diffusion dissolution indicate that, despite oscillations inherent in the aqueous concentration profile produced by ET formulations, greater accuracy may be achieved with less computations effort and numerical complexity than with FT schemes for large classes of transport episodes in which the reactive solid concentration does not exceed significantly the aqueous concentration of the solute species. The retention of the simplicity of ET methods is a desirable element in the development of a general multicomponent code for modeling more complex problems involving multiple precipitation/dissolution fronts with aqueous complexation and sorption. (See also W90-03036) (Rochester-PTT)
W90-03077

ASSESSMENT OF THERMAL IMPACTS OF DISCHARGE LOCATIONS USING FINITE ELEMENT ANALYSIS.
Stone and Webster Engineering Corp., Boston, MA.
Y. C. Chang, and D. P. Galya.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 313-318, 3 fig, 1 tab, 7 ref.

Descriptors: *Mathematical studies, *Path of pollutants, *Finite element method, *Model studies, *Florida, *Gulf of Mexico, *Thermal pollution, Plumes, Tidal effects, Coastal waters, Simulation, CAFE model, DISPER model, Reefs, Crystal Bay, Mathematical models.

The finite-element computer models CAFE and DISPER were used to simulate thermal plumes for effluent discharge into Crystal Bay, Gulf of Mexico, Florida. The models were modified to reflect the restrictions in flow due to oyster reefs. The models, in conjunction with a vertically mixed near-field model, were successfully applied to simulate thermal plumes for offshore discharges. The results show clearly the influence of discharge locations and identify areas to be included in a biological impact assessment. Thermal isotherms are plotted for the high-water slack (HWS) and the low-water slack (LWS). The HWS condition results in a shoreward plume reflective of the currents on the flood tide, whereas the LWS condition results in a plume extending farther offshore, reflective of the currents on the ebb tide. Because of the shallow depths, the thermal plumes of the LWS are larger than those of HWS. The thermal plume size could be reduced by discharging offshore at deeper water locations where the influence from the shoreline and oyster reef is less significant. (See also W90-03036) (Rochester-PTT)
W90-03081

COMPUTER MODEL FOR THE ESTIMATION OF EFFLUENT STANDARDS FOR PRIORITY POLLUTANTS FROM A WASTEWATER DISCHARGE BASED UPON AQUATIC LIFE CRITERION OF THE RECEIVING STREAM.
For primary bibliographic entry see Field 5G.
W90-03088

GROUNDWATER TRACING AND WATER QUALITY ANALYSIS IN THE VICINITY OF A LANDFILL IN COUNTY MONAGHAN, IRELAND.
Monaghan County Council (Ireland).
For primary bibliographic entry see Field 2F.
W90-03150

PARTICULAR DIFFICULTIES IN DETERMINING HYDRAULIC AND SOLUTE-TRANSPORT PARAMETERS IN CARBONATE ROCKS.
Purdue Univ., Lafayette, IN. Dept. of Earth and Atmospheric Sciences.
For primary bibliographic entry see Field 2F.
W90-03151

COMBINED TRACER EXPERIMENTS--AN IMPORTANT TOOL FOR THE DETERMINATION OF THE SORPTION CAPABILITY OF A KARST AQUIFER.
Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). Dept. of Hydrogeology.
For primary bibliographic entry see Field 2F.
W90-03156

FISSURED AQUIFEROUS KNOWLEDGE: TRUMPS AGAINST POLLUTION.
Lille-1 Univ., Villeneuve d'Ascq (France). Lab. de Geologie Appliquee.
For primary bibliographic entry see Field 2F.
W90-03160

REGIME OF THE QUALITY OF KARST GROUND WATERS IN EASTERN SERBIA--YUGOSLAVIA.
Belgrade Univ. (Yugoslavia). Faculty of Mining and Geology.
Z. P. Stevanovic.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1000-1005, 3 fig, 4 ref.

Descriptors: *Groundwater pollution, *Groundwater quality, *Karst, *Yugoslavia, *Water pollution sources, Flow profiles, Filtration, Bacteria, Flow discharge, Public health.

Quality tests applied to the karst groundwaters in eastern Serbia, indicate relatively uniform properties throughout the year, with certain seasonal variations. Investigations were conducted on 105 karst springs and included elementary chemical analyses, gas composition, radioactivity, and bacteriological studies. The variations depend primarily on the spring flow regime and the discharge peak. The chemical composition of these waters is usually pure (sanitary), especially in the catchment areas on unpopulated mountain massifs. Cavern and channel dimensions, and high filtration rapidity, cause frequent bacteriological pollution so that a wider zone of sanitary protection for the entire catchment area should be proclaimed. During periods of heavy precipitation, groundwater flows very rapidly and self-purification capabilities are hindered. This has caused several water-borne epidemics in small towns in Serbia during the last 15 years. (See also W90-03104) (Author's abstract)
W90-03161

DUAL-POROSITY MEDIUM MODEL OF CONTAMINANT TRANSPORT AND ITS APPLICATION IN A KARST AQUIFER IN JINAN.
Changchun Coll. of Geology (China).
T. Yang, X. Xie, H. Wang, and D. Xi.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1012-1021, 5 fig, 2 ref.

Descriptors: *Porous media, *Model studies, *Path of pollutants, *Aquifers, *Karst hydrology, China,

Jinan City, Advection, Dispersion, Mathematical models, Finite element method, Chlorides.

A dual-porosity medium model is presented for the problem of contaminant transport in fractured aquifers. This model takes into account two-dimensional advection and dispersion in fractures and two-dimensional molecular diffusion in porous blocks and at the fracture-matrix interfaces. Expressions and calculations of the coupling factor 'gamma' (mass exchange) for porous matrices of different geometries such as prismatic block, elliptic cylinder, etc. are given which make the dual-porosity transport model applicable to general natural fractured aquifers. A new numerical solution mixed finite element method is developed for solving the model. The model has been successfully used for simulating the behavior of chloride ion in a karst area (about 85 sq km) in the east suburb of Jinan city, China. (See also W90-03104) (Author's abstract)
W90-03163

EXAMINATION OF ORGANIC SELF-PURIFICATION OF KARST UNDERGROUND WATERCOURSES ON THE EXPERIMENTAL PROVING GROUND IN EAST HERZEGOVINA.
Andrija Stampar School of Public Health, Zagreb (Yugoslavia).
For primary bibliographic entry see Field 2F.
W90-03164

HEAVY METALS AS INDICATORS OF WATER RELATIONS IN KARST AND PROTECTION PROBLEMS.
Titograd Univ. (Yugoslavia). Inst. of Medicine.
S. Filipovic.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1037-1045, 1 fig, 1 tab, 5 ref.

Descriptors: *Wastewater pollution, *Path of pollutants, *Heavy metals, *Groundwater pollution, *Karst, Groundwater quality, Karst hydrology, Groundwater movement, Tracers, Iron, Zinc, Nickel, Cadmium, Chromium, Lead, Water pollution sources, Industrial wastewater, Municipal wastewater.

The natural level of heavy metals (Fe, Zn, Cr, Cd, Ni and Pb) in water, along with the addition of further quantities by wastewater, enable a determination to be made of the communication between the karst conducting systems. The area investigated is a coastal zone of deep karst which is occupied by a town that discharges its domestic and industrial wastewaters into the karst underground area through a system of sinkholes. Several points were selected as measurement points on the basis of tracer tests. The measurements showed that the uncontrolled discharge of untreated wastewaters gave rise to a considerable increase of heavy metal concentrations in the groundwater and deterioration of water quality at springs. (See also W90-03104) (Lantz-PTT)
W90-03166

POINT SOURCE POLLUTION IN KARST AREAS IN IRELAND.
Geological Survey of Ireland, Dublin.
C. R. Aldwell, R. H. Thorn, and D. Daly.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1046-1051, 1 fig, 11 ref.

Descriptors: *Water pollution sources, *Karst, *Ireland, *Groundwater quality, Water quality, Bacteria, Ammonia, Septic tanks, Domestic wastes, Farm wastes, Coliforms.

Almost half of Ireland is underlain by Carboniferous limestones, many of which are karstified. In the karst areas, more than 70% of water supply comes from groundwater. In Ireland, groundwater quality is generally good. Diffuse pollution sources such as inorganic fertilizers, have not caused significant problems and are not likely to in the future. However, many wells (more than 50% in places) particularly in karst areas, are contaminated by fecal bacteria and/or ammonia. The main sources of such pollution are septic tank effluent, farmyard wastes and sinking streams. (See also W90-03104) (Author's abstract)
W90-03167

GROUNDWATER VULNERABILITY IN SOME KARST AREAS OF HYBLEAN FORELAND (SE SICILY).
Catania Univ. (Italy). Ist. di Scienza della Terra.
For primary bibliographic entry see Field 2F.
W90-03168

NUCLEAR GROUNDWATER PROTECTION.
Bergakademie Freiberg (German D.R.). Dept. of Geosciences.
For primary bibliographic entry see Field 5G.
W90-03170

MINING DRAINAGE OF A KARSTIC AQUIFER AND THE RELATED PROTECTION PROBLEMS (OLKUSZ MINING DISTRICT, POLAND).
Academy of Mining and Metallurgy, Krakow (Poland). Inst. of Hydrogeology and Engineering Geology.
For primary bibliographic entry see Field 2F.
W90-03174

SORPTION OF NONPOLAR ORGANIC CHEMICALS ON LOW-CARBON-CONTENT AQUIFER MATERIALS.
Air Force Engineering and Services Center, Tyndall AFB, FL. Engineering and Services Lab.
T. B. Stauffer, W. G. MacIntyre, and D. C. Wickham.
Environment Toxicology and Chemistry ETOCDK, Vol. 8, No. 10, p 845-852, 1989. 3 fig, 4 tab, 23 ref.

Descriptors: *Solute transport, *Path of pollutants, *Contamination, *Organic compounds, *Sorption, *Groundwater pollution, *Aquifer characteristics, Carbon radioisotopes, Sediments, Cleanup, Benzenes, Statistical analysis, Organic carbon, Sand, Clays, Silt, Cation exchange, Iron.

Sorption on aquifer materials retards the transport of organic chemicals in ground water and this retardation can be calculated if the sorption isotherm is known. Results from these calculations can be used to determine appropriate cleanup methods at sites of high contaminant concentration and to determine long-term distribution of dilute chemicals that cannot be recovered by cleanup procedures. A simple sorbent characterization parameter for aquifer materials that would allow sorption prediction without isotherm measurement would make it easier to apply ground water contaminant transport models to site-specific contamination conditions. The objective of this study was to determine whether sorption coefficients could be predicted using aquifer material properties. Sorption isotherms were measured by batch equilibration methods for three nonpolar organic sorbates on seven subsurface, low-carbon sedimentary aquifer materials. Radiolabeled (C14) 1-methylnaphthalene, o-dichlorobenzene and naphthalene were separately equilibrated with the sorbents to determine sorption coefficients (K). Chemical and physical properties of the aquifer materials were determined. Possible relationships between sorption coefficients and organic carbon (OC) content and other sorbent properties were investigated using multivariate statistics. Sorbent properties used in the statistical analysis were sorption coefficients, percentage OC, percentage sand, percentage clay, percentage silt, specific surface area, cation exchange capacity, percentage 1:1 clay, percentage 2:1 clay and percentage iron content. No predictive relationships between sorption coefficients and aquifer material properties were found. The sorption coefficient does not correlate with any of the properties of the aquifer materials, including OC content for aquifer materials with OC content of less that 0.10%. It is recommended that sorption coefficients be determined experimentally on each different aquifer material for use in ground water transport calculations. (Author's abstract)
W90-03202

THERMAL MODULATION OF BENZO (ALPHA) PYRENE UPTAKE IN THE GULF TOADFISH, OPSANUS BETA.
Simon Fraser Univ., Burnaby (British Columbia). Environmental Toxicology Program.
C. J. Kennedy, K. A. Gill, and P. J. Walsh.
Environment Toxicology and Chemistry ETOCDK, Vol. 8, No. 10, p 863-869, 1989. 2 fig, 1 tab, 27 ref. NIH Grant ES-04361.

Descriptors: *Path of pollutants, *Toxicity, *Temperature effects, *Fish, *Bioaccumulation, *Carcinogens, Organic compounds, Water pollution effects.

The toxicity of many xenobiotics to aquatic species can be altered by changes in water quality parameters (such as temperature) that affect the amount of chemical taken up and accumulated. Temperature has also been implicated as a modulating factor in carcinogenesis in fish. The purpose of this study was to examine the effects of long-term temperature acclimation in concert with acute temperature change on the uptake and disposition of a model xenobiotic compound. Gulf toadfish, Opsanus beta, were exposed to initial (C14) benzo(alpha)pyrene (BaP) concentrations of 5 micrograms/L in a simple static system at high and low temperatures (18 or 28 degrees C) following long-term (>4 weeks) acclimation to these temperatures or an acute temperature change (18 to 28 degrees C or 28 to 18 degrees C) to assess the effects of temperature on the uptake and disposition of BaP. BaP uptake was estimated from the disappearance of BaP from the water. Uptake rates estimated at initial BaP concentrations for the four temperature treatments (acclimation temperature:exposure temperature), 28:18, 28:28, 18:18, and 18:28 degrees C, were 0.020 +/-0.001, 0.051 +/-0.005, 0.031 +/-0.004 and 0.065 +/-0.004 micrograms BaP/g body weight/h (+/-SE, N=6). The decrease in BaP uptake with decreasing BaP concentration indicates that BaP uptake is directly proportional to the concentration in water. The calculated increase in physiological or biochemical rate for a 10 degree increase in temperature (Q sub 10) suggest that uptake is modulated by temperature-induced changes in respiration rate or convection volume. BaP was detected in all tissues examined, with the highest levels in the bile, the liver, the kidney and the gills. Greater uptake rates of carcinogens such as BaP at higher temperatures may in part explain higher rates of tumor formation in fish exposed to carcinogens at high temperatures. These results indicate that environmental variables must be taken into consideration when comparing or extrapolating results from study to study. (Author's abstract)
W90-03204

FATE OF NAPHTHENIC HYDROCARBONS IN THE BILE OF RAINBOW TROUT (SALMO GAIRDNERI).
Department of Fisheries and Oceans, St. John's (Newfoundland). Science Branch.
J. Hellou, J. H. Banoub, and A. Ryan.
Environment Toxicology and Chemistry ETOCDK, Vol. 8, No. 10, p 871-876, 1989. 3 fig, 2 tab, 26 ref.

Descriptors: *Path of pollutants, *Biodegradation, *Aromatic compounds, *Hydrocarbons, *Fate of pollutants, *Trout, *Metabolites, *Bioaccumulation, Gas liquid chromatography, Thin layer chromatography, Mass spectrometry, Nuclear magnetic resonance, Petroleum products, Oil, Drilling fluids.

In crude and refined oils, aromatics represent 15 to 40% of the hydrocarbon mixture, while in drilling mud-based oils, the aliphatics and naphthenes constitute more than 95% of the components. When vertebrates (including fish) are exposed to pollut-

ants of the aromatic and terpenoid type, metabolic transformation takes place. Fewer studies have focused on saturated hydrocarbons. The present study tried to answer the following: (a) Do small naphthenic molecules concentrate in the gall bladder bile as glucuronides, (b) Does aromatization of saturated cyclic molecules take place in fish, (c) Given the same molecular weight, number of rings and type of side chain, would an aromatic molecule be metabolized at the same position as a naphthenic molecule. Rainbow trout (Salmo gairdneri) were exposed orally to n-butylcyclohexane and on the sixth day after ingestion, 3 to 5% of the dose of parent compound was recovered as a metabolite in the bile. The glucuronide of cis-3-n-butylcyclohexanol was identified as the single metabolic product using gas-liquid and thin layer chromatography and C13 and H1 NMR spectroscopy. Exposure of trout to t-butylcyclohexane afforded the glucuronide of 4-t-butylcyclohexanol in a much smaller amount. Enzymatic aromatization of these relatively small saturated cyclic molecules was not observed prior to conjugation with glucuronic acid. The results indicate that the metabolism of naphthenic molecules is different from that of closely related aromatic molecules. (Author's abstract)
W90-03205

DYNAMICS OF ORGANOCHLORINE COMPOUNDS IN HERRING GULLS: III. TISSUE DISTRIBUTION AND BIOACCUMULATION IN LAKE ONTARIO GULLS.
National Wildlife Research Centre, Ottawa (Ontario).
B. M. Braune, and R. J. Norstrom.
Environment Toxicology and Chemistry ETOCDK, Vol. 8, No. 10, p 957-968, 1989. 3 fig, 2 tab, 49 ref.

Descriptors: *Bioaccumulation, *Gulls, *Eggs, *Path of pollutants, *Animal tissues, *Chlorinated hydrocarbons, *Lake Ontario, Tissue analysis, Polychlorinated biphenyls, DDT, DDE, Waterfowl, Food chains, Aquatic life, Water pollution effects.

Organochlorine compounds are accumulated in the body fat of gulls. At egg formation, they are transferred along with fat to the yolks, so that their concentration in eggs are a measure of the exposure of the female to contaminants in food. In this study, apparent biomagnification factors (BMFs, wet weight basis) for organochlorine compounds in herring gulls (Larus argentatus) in Lake Ontario were shown to be related to chlorine substitution patterns in the case of polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). PCBs accumulated according to the availability of adjacent positions not substituted with chlorine: (a) para-meta unsubstituted (P group), mean BMF 20 +/-6.2; (b) meta-ortho unsubstituted (M group), mean BMF 87 +/-36; and (c) no adjacent unsubstituted positions (blocked, B group), mean BMF 154 +/-39. Among the other organochlorines, DDT, cis-nonachlor and trans-nonachlor, dieldrin and octachlorostyrene magnified to the least extent (BMF 3-19), and photomirex, mirex and DDE magnified to the greatest extent (BMF 85-100). Of the PCDDs and PCDFs, 2,3,7,8-TCDD and 2,3,4,7,8-PnCDF biomagnified to a greater degree than did other congeners (BMF 32 and 7, respectively). There were no significant differences among egg-to-whole-body ratios (mean 0.60 +/-0.11, lipid weight basis) for any of the organochlorines except PCDDs and PCDFs, indicating that partitioning among lipid pools in the body is the main determining factor in tissue distribution. Egg-to-whole-body ratios for PCDDs (mean 1.2 +/-0.33) and PCDFs (mean 0.87 +/-0.02) were higher than but not significantly different from those for other organochlorines. Liver-to-whole-body ratios (mean 0.80 +/-0.16) also did not differ significantly among organochlorines, except that heptachlor epoxide, dieldrin, PCDDs and PCDFs had higher ratios. The mean fraction of the total body burden of PCDDS and PCDFs contained in the liver ranged from 5 to 55%, compared with 1 to 5% among the other organochlorines, and it increased with degree of chlorination. The high relative BMFs in gulls compared with those in fish can be explained by the higher energy requirement of the gull. (Author'sabstract)

W90-03214

SOIL, WATER, AND VEGETATION RESIDUES OF 2,4,5-T APPLIED TO A NEW ZEALAND HILLSIDE.
Department of Scientific and Industrial Research, Hamilton (New Zealand). Water Quality Centre.
M. E. Fox, and R. J. Wilcock.
New Zealand Journal of Agricultural Research NEZFA7, Vol. 31, No. 3, p 347-357, a988. 3 fig, 3 tab, 25 ref.

Descriptors: *Path of pollutants, *New Zealand, *Herbicides, *Spraying, *Soil contamination, *Vegetation effects, *Environmental effects, *Water pollution, Organic compounds, Pastures, Agricultural chemicals, Agricultural watersheds.

A steep hill country area (1.66 ha) of gorse and pasture was sprayed with 2,4,5-T butyl ester by air. Soil and vegetation samples were collected at regular intervals and a stream at the bottom of the trial area was monitored continuously over 6 months. Only 0.6% of the applied herbicide entered the stream during the trial, with 0.4% being washed out in the first storm. Measurable traces of the original ester formulation, 2,4,5-T acid, and the principal breakdown product, 2,4,5-trichlorophenol (2,4,5-TCP), with a combined average of about 0.4 mg/kg, were found in pasture vegetation 6 months after initial application. The persistence of these residues may be a cause of dietary intake by grazing livestock. Soil residues (expressed as butyl ester) persisted throughout the study, principally as 2,4,5-TCP (12-100 ng/g after 185 days), and were also detected from a treatment 1 year before the trial began (20-90 ng/g). An estimate of the masses of residues and losses 6 days after spraying accounted for about 20% of the applied mass. A significant part of the balance (80%) is thought to have been lost in spray drift. Damage to sensitive non-target vegetation (horticultural or native flora) caused by spray drift may be the major environmental threat from 2,4,5-T. The widespread use of 2,4,5-T for nearly 40 years has caused minimal damage to the aquatic environment. Residues in soils are relatively immobile but may contribute to the prolonged duration of 2,4,5-T material in vegetation. Atmospheric pollution is perhaps an inevitable consequence of the scale of use of herbicides for controlling brush weeds, and will be a problem for whatever herbicides replace 2,4,5-T. (Author's abstract)
W90-03230

CULTIVATION OF UPLAND RICE IN DREDGED ESTUARINE LAGOON SPOILS, WITH EMPHASIS ON THE CHEMICAL PROPERTIES OF THE SEDIMENT.
Tohoku Univ., Sendai (Japan). Biological Inst.
For primary bibliographic entry see Field 5E.
W90-03234

TURNOVER OF EXTRACELLULAR DNA IN EUTROPHIC AND OLIGOTROPHIC FRESHWATER ENVIRONMENTS OF SOUTHWEST FLORIDA.
University of South Florida, St. Petersburg. Dept. of Marine Science.
For primary bibliographic entry see Field 2H.
W90-03236

EMERGING LEGAL ISSUES IN GROUNDWATER CONTAMINATION CASES.
Huey, Guilday, Kuersteiner and Tucker, Tallahassee, FL.
For primary bibliographic entry see Field 2F.
W90-03243

LABORATORY MODELS FOR ASSESSING THE FATE OF GROUNDWATER CONTAMINANTS.
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
J. J. Delfino, P. V. Cline, and C. J. Miles.
Florida Scientist FLSCAQ, Vol. 52, No. 3, p 207-213, Summer 1989. 2 fig, 1 tab, 16 ref.

Descriptors: *Path of pollutants, *Model studies, *Fate of pollutants, *Groundwater pollution, *Florida, *Water pollution effects, Hazardous wastes, Aldicarb, Organic wastes, Industrial wastes, Degradation, Hydrolysis, Toxicity, Infiltration, Water pollution effects, Biodegradation, Aerobic conditions, Anaerobic conditions.

Laboratory microcosms were used to model the fate of aldicarb, industrial and petroleum derived organic chemicals, and the abiotic conversion of 1,1,1-trichloroethane (TCA) to 1,1-dichloroethane (1,1-DCA) in groundwater. Aldicarb had an average first order alkaline hydrolysis half life of 63 days under aerobic groundwater conditions but this rate extended to over 600 days under anaerobic conditions. Aldicarb and the sulfoxide were found to be relatively toxic to zooplankton species. Biodegradation experiments using p-cresol, methyl ethyl ketone, benzene, and naphthalene showed that all four of the target compounds degraded completely under aerobic conditions with rates ranging from eight days to 16 days. These rates were slowed under anaerobic conditions. Anaerobic biodegradation of TCA resulted primarily in the formation of 1,1-DCA and cis-(1,2)-dichloroethene, with 1,1-dichloroethene (1,1-DCE). Abiotic degradation experiments with TCA showed first order kinetics as it degraded to 1,1-DCE. (Geiger-PTT)
W90-03244

IN VIVO BINDING OF EXOGENOUS COPPER TO HAEMOLYMPH FRACTIONS OF ESTUARINE CRAB SCYLLA SERRATA (FORSKAL).
Madras Univ. (India). Lab. of Pathobiology.
R. Balaji, P. Mullainadhan, and M. Arumugam.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 128, No. 3, p 241-255, June 1989. 4 fig, 1 tab, 51 ref. University Commission Grants F.8-56(Sc.)/88,SA-I and F.3-154/87,SR-II.

Descriptors: *Copper, *Blood, *Crabs, *Estuarine fisheries, *Bioaccumulation, *Path of pollutants, Water pollution effects, Heavy metals, Adsorption.

Binding of copper to different hemolymph fractions (plasma, hemocyanin, clarified plasma and hemocytes) was quantitatively determined in crab specimens injected with Cu as cupric chloride. As a prerequisite to this study, a suitable amount of Cu for injection was empirically selected by injecting various amounts of Cu into the hemocoel of crabs and monitoring the consequent changes in hemolymph-Cu level at different time intervals post-injection. An injection dose of 10 micromoles was found to be suitable to investigate in vivo binding of exogenous Cu to different hemolymph fractions. In the hemolymph of uninjected crabs, no free Cu was detectable, 86% of the total hemolymph Cu was found in association with plasma proteins and 13% is associated with hemocytes (hemocyte lysate supernatant). Analysis of protein in hemocyanin fraction isolated from plasma revealed that 83% of the protein in plasma is hemocyanin. When the crabs were injected with 10 micromoles Cu, no free Cu was detectable in any of the hemolymph fractions tested at any time post-injection, the first hemolymph sample was analyzed at 30 min post-injection. At 2 hr post-injection, the Cu concentration in hemocyanin and hemocyte-lysate supernatant increased significantly and accounted for 63 and 20% of the total injected Cu, respectively. These observations demonstrate that hemocyanin and hemocytes play a significant role in binding exogenous Cu. The Cu level in these fractions decreased thereafter and reached almost the pre-injection level within 4 hr post-injection. Concomitantly at this hr of post-injection, the protein level in hemocyanin and hemocytes decreased significantly. These observations clearly indicate the disappearance of excess Cu from circulation along with the carrier proteins and suggest a probable role of hemocyanin and hemocytes in transport of exogenous heavy metals. (Author's abstract)
W90-03258

EFFECT OF PESTICIDES ON THE GROWTH OF AQUATIC HYPHOMYCETES.
Mangalore Univ. (India). Dept. of Biosciences.

For primary bibliographic entry see Field 5C.
W90-03264

FACTORS AFFECTING ZINC CONCENTRATIONS IN PLANTS GROWN IN SLUDGE-AMENDED SOILS.
Massachusetts Univ., Amherst. Dept. of Plant and Soil Sciences.
P. Milner, and A. V. Barker.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 20, No. 1-2, p 1-21, Jan 1989. 5 fig, 3 tab, 23 ref.

Descriptors: *Path of pollutants, *Plant growth, *Sludge disposal, *Land disposal, *Soil amendments, *Endive, *Lime, *Sludge utilization, *Zinc, *Acidic soils, Hydrogen ion concentration, Plant growth, Silt, Loam, Sand.

Endive (Chicorium endivia L.), a crop tolerant of acid soil conditions, was grown in a loamy sand, a loam, and a silt loam in a greenhouse. The soils were treated with limestone and a high-calcium sewage sludge and with five levels of Zn ranging from 0 to 800 mg/kg. Limed soils were about pH 6-6.5, compared to pH 4.5-5 for unlimed soils. Zinc concentrations in shoots of endive grown in limed soils were less than those in unlimed soils. Sludge increased Zn concentrations in plants grown in the loam or silt loam but not in the loamy sand. The pH of the loamy sand was increased by the addition of sludge and may have limited Zn entry into the plants. A second addition of sludge enhanced Zn levels in plants, and the effects of the sludge appeared to be related to the resultant soil pH. (Author's abstract)
W90-03301

NITRATE IN RUNOFF WATER FROM CONTAINER GROWN JUNIPER AND ALBERTA SPRUCE UNDER DIFFERENT IRRIGATION AND N FERTILIZATION REGIMES.
Connecticut Agricultural Experiment Station, New Haven. Dept. of Soil and Water.
T. M. Rathier, and C. R. Frink.
Journal of Environmental Horticulture JEHOD5, Vol. 7, No. 1, p 32-35, Mar 1989. 1 fig, 2 tab, 11 ref.

Descriptors: *Nitrates, *Irrigation effects, *Fertilization, *Water pollution sources, *Spruce trees, *Juniper trees, Plant growth, Nitrogen, Trickle irrigation, Irrigation, Groundwater pollution.

Juniperus horizontalis Moench 'Plumosa Compacta Youngstown' (compact Andorra juniper) and Picea glauca Moench (Voss) 'Conica' (dwarf Alberta spruce) were grown for one season in 2.2 L (No. 1) nursery containers in a potting medium containing composted hardwood bark, sphagnum peat moss and sand (1:1:1 by vol). The containers were placed over lysimeters permitting continuous collection and measurement of water passing through and around the containers. Slow release or soluble N was applied at an annual rate of 1.6 g of N per pot. Containers were irrigated by either trickle or overhead methods and water volumes were recorded. Subsamples of leachate were collected and analyzed for nitrate. Much less nitrate was leached by the trickle than by the overhead irrigation. Although slow release n sources lost considerably less nitrate in runoff water, there is still sufficient nitrate lost by these sources to pollute groundwater unless annual fertilizer needs are supplied by split applications. Depending on sources, 58-80% of the N applied as slow release fertilizers was not recovered in either the plant or runoff water. (Author's abstract)
W90-03314

STOCHASTIC SIMULATION MODEL OF OIL SPILL FATE AND TRANSFER.
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Water Resources and Environment Div.
A. H. Al-Rabeh, H. M. Cekirge, and N. Gunay.
Applied Mathematical Modelling AMMODL, Vol. 13, No. 6, p 322-329, June 1989. 10 fig, 45 ref.

Descriptors: *Model studies, *Path of pollutants, *Fate of pollutants, *Water pollution treatment,

*Oil spills, *Mathematical models, *Dispersants, Stochastic process, Environmental protection, Advection, Pollutants, Petroleum products.

Over the past few years, considerable research has been directed toward the development of mathematical models to describe the behavior of oil spills. A successful model would be of great value in selecting locations for the deployment of containment and collection systems to mitigate the effects of the pollutant on the environment. In this study, a comprehensive stochastic model is formulated to simulate the fate and transport of oil spills. The model consists of a set of algorithms describing the processes of advection, turbulent diffusion, surface spreading, vertical mechanical dispersion, emulsification, and evaporation. Each algorithm is developed separately and is linked to related processes and to environmental and other parameters. The model requires as input the velocity field of the transporting medium. This can be obtained from a three-dimensional hydrodynamic model for tidal and wind-driven currents for the region of interest. The oil spill fate and transport model is used to simulate a surface oil spill in the Abu Ali region on the western side of the Arabian Gulf. The simulation results indicate that the model can predict the fate and transport of oil slicks with reasonable accuracy. (Author's abstract)
W90-03320

FORAGING IN CENTRAL VALLEY AGRICULTURAL DRAINAGE AREAS.
California Univ., Davis. Dept. of Applied Behavioral Sciences.
For primary bibliographic entry see Field 6G.
W90-03323

SURFACE THERMAL PLUME IN CHANNEL.
University of Western Ontario, London. Faculty of Engineering Science.
R. E. Baddour, and H. A. Farghaly.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 7, p 869-886, July 1989. 16 fig, 2 tab, 30 ref.

Descriptors: *Diffusion, *Plumes, *Thermal pollution, *Wastewater disposal, Channels, Mathematical models, Hydraulics, Turbulent flow, Stratified flow, Temperature effects, Surface flow.

Thermal and other wastewater discharges into the environment generate turbulent jets, a nonbuoyant flow, and plumes, a buoyant flow. In order to investigate the summer behavior of a surface thermal plume in a deep channel an integral model based on the concept of turbulent entrainment decay in stably stratified shear flows was used to predict the development of supercritical surface plumes. The turbulent structure of the plume was examined using flow visualization and measurements of temperature fluctuations. In a deep channel, a supercritical plume reaches a terminal state, which is well-scaled using the momentum function and the buoyancy flux. The terminal state of the plume is affected by the critical Richardson number, but is independent of the shape of the entrainment function. The collapsing turbulence beyond the entrainment zone is characterized by a transfer of energy to lower-frequency fluctuations and a shift towards a smaller rate of energy decay. (Ence-PTT)
W90-03330

EXPERIMENTAL INVESTIGATION OF SHALLOW RECIRCULATING FLOWS.
McGill Univ., Montreal (Quebec). Dept. of Civil Engineering and Applied Mechanics.
For primary bibliographic entry see Field 2L.
W90-03332

NOTE ON AYOUB'S DATA OF HORIZONTAL ROUND BUOYANT JET IN CURRENT.
Hong Kong Univ. Dept. of Civil and Structural Engineering.
For primary bibliographic entry see Field 5E.
W90-03336

CADMIUM UPTAKE BY A PHYTOPLANKTON SPECIES IN THE PRESENCE OF DIFFERENT INHIBITORS.
Station Zoologique, Villefranche-sur-Mer (France).
M. Romeo, M. Gnassia-Barelli, C. S. Karez, and S. Puiseux-Dao.
Toxicological and Environmental Chemistry TXECBP, Vol. 22, No. 1-4, p 97-100, 1989. 2 tab, 7 ref. CNRS Grant No. CNRS-AIP 1335.

Descriptors: *Cadmium, *Bioaccumulation, *Phytoplankton, *Path of pollutants, Enzymes, Calcium, Aquatic plants, Plankton, Heavy metals.

The uptake of cadmium by the Haptophyceae Hymenomonas elongata was studied as regards the energetic processes and Ca-transport. For this purpose, experiments were carried out in the presence of an uncoupler of the phosphorylation, m-chlorophenylhydrazone carbonyl cyanide (CCCP), and of a inhibitor of calcium channels and also of Ca(+2)-ATPase, verapamil. To reduce the number of assays, a factorial experimental design was used, in which all variables (concentration of Cd in the medium, incubation time, and the presence of the inhibitor) are at two levels. In the absence of inhibitor, Cd uptake was found to vary as a function of metal concentration in the medium and of incubation time. CCCP significantly increased Cd uptake by H. elongata at sufficient incubation time. Therefore Cd uptake seemed linked to an energy-dependent process, involving an ATPase. Verapamil immediately increased Cd uptake, implying an interaction between Cd and Ca. (Author's abstract)
W90-03346

MERCURY DISTRIBUTION IN MARITIME SEDIMENT AND ITS CORRELATION WITH THE POSIDONIA OCEANICA PRAIRIE IN A COASTAL AREA AFFECTED BY A CHLOR-ALKALI COMPLEX.
Consiglio Nazionale delle Ricerche, Pisa (Italy). Ist. di Biofisica.
R. Ferrara, B. E. Maserti, and P. Paterno.
Toxicological and Environmental Chemistry TXECBP, Vol. 22, No. 1-4, p 131-134, 1989. 1 fig, 2 tab, 8 ref.

Descriptors: *Mercury, *Sediments, *Marine sediments, *Aquatic plants, *Path of pollutants, *Benthic flora, *Coastal waters, *Industrial wastewater, *Bioaccumulation, *Bioindicators, Pollutant identification, Water pollution effects, Spectroscopy, Atomic absorption spectroscopy, Heavy metals.

Mercury concentrations in marine sediment over a large coastal area located opposite a chlor-alkali (industrial) complex were measured. The values ranged from 0.12 microgram/g to 6.48 microgram/g, d.w. In the same area mercury levels in some organs of the marine phanerogam Posidonia oceanica were measured (leaves 0.022-0.075 micrograms/g, f.w.; rhizomes 0.033-0.235 micrograms/g, f.w.; roots 0.080-0.249 micrograms/g, f.w.). A distinct correlation between the mercury content of the sediment and that present in the different parts of the plant was observed, suggesting a possible use of Posidonia oceanica as a biological indicator. It was also concluded that the sediments constitute a sink of the mercury which is slowly released into the aquatic environment. (Author's abstract)
W90-03347

BIOACCUMULATION OF CADMIUM BY LUMBRICUS TERRESTRIS.
Geneva Univ. (Switzerland). Dept. Chimie Minerale, Analytique et Appliquee.
S. Ramseier, M. Martin, W. Haerdi, P. Honsberger, and G. Cuendet.
Toxicological and Environmental Chemistry TXECBP, Vol. 22, No. 1-4, p 189-196, 1989. 6 fig, 20 ref.

Descriptors: *Bioaccumulation, *Cadmium, *Path of pollutants, *Annelids, *Food chains, *Septic sludge, *Soil environment, Soil contamination,

Wastewater, Fauna, Heavy metals, Atomic absorption spectroscopy.

Due to their intense activity, earthworms are in contact with most substances found in soils and can even concentrate some of them. As they are the prey of numerous predators, earthworms represent an essential link in trophic chains. Two experiments were carried out to determine cadmium bioaccumulation in Lumbricus terrestris (Oligochaeta--Annelida). In the first one, cadmium-contaminated sewage sludge was added to an earthworm culture. The worms' cadmium content increased, related to culture residence time (up to six months) whereas, in the control culture, such an increase was not observed even though the cadmium content of the worms was greater than soil cadmium content. Cadmium was analyzed in some groups of organs. The results show that cadmium is mainly accumulated in intestinal and associated chloragogenous tissue compartment. From 85 to 95% of total cadmium mass found in the worms was located in this organ (control worms as well as contaminated worms). Intestinal cadmium concentration rose to 120 ppm in contaminated culture where soil cadmium content was 3 ppm. In the second experiment, earthworms were exposed to intentionally contaminated food. Bioaccumulation was also found to be significant. This observation seems to show that a part of resorbed cadmium comes from the digestive system where it can diffuse in the whole organism as observed. A cadmium increase in excrements was also observed when the cadmium content of the worms was sufficiently high. (Author's abstract)
W90-03348

DETERMINATION AND DISTRIBUTION OF HYDROXYLATED AROMATIC COMPOUNDS IN ESTUARINE WATERS.
Cochin Univ. of Science and Technology (India). Div. of Chemical Oceanography.
For primary bibliographic entry see Field 5A.
W90-03349

HEAVY METALS IN COASTAL SEDIMENTS IN GUIPUZCOA (SPAIN).
Universidad del Pais Vasco, San Sebastian (Spain). Lab. Contaminacion.
I. Legorburu, A. Ramos, and M. Sola.
Toxicological and Environmental Chemistry TXECBP, Vol. 23, No. 1-4, p 129-134, 1989. 2 fig, 5 tab, 5 ref.

Descriptors: *Spain, *Path of pollutants, *Estuaries, *Marine sediments, *Heavy metals, *Coastal waters, *River mouth, *Industrial wastes, *Pollution index, Morphology, Aluminum, Cadmium, Copper, Chromium, Iron, Manganese, Nickel, Lead, Zinc, Organic matter, Atomic absorption spectroscopy, Water pollution, Bay of Biscay.

Surface sediment samples were taken from the coastal area of Guipuzcoa at depths of 10, 20 and 50 m. Four series of samplings were taken in July and November of 1986 and February and May of 1987. The samples were wet digested (HNO3-HCl-HF) and analyzed by atomic absorption spectroscopy. The background values in the area were determined from the logarithmic representation of the frequency distribution of each metal. Those values were in the range of mean metal levels in limestone and sandstone. Of these metals, chromium, iron, manganese, lead, and zinc levels were influenced by depth; aluminum and organic matter levels were influenced by season; and only chromium, iron, manganese, lead, and zinc levels were influenced by location (nearby river). These data indicate that estuarine morphology (shore line, bathimetry, etc.) is the primary influence on the distribution of the sediment. The Pollution Load Index (PLI) was calculated for every station. A comparison between the PLI at 10 and 50 m depth sediments shows the continental origin of the metals: Heavily industrialized areas presented a high PLI in the total sediment at low depth and their influence reached the sediment at 50 m. Metal inputs of continental origin are especially important in Deva, Oria and Urola river mouths. The sediments of the coastal area of Guipuzcoa have a low metal background level, but inputs of polluted

materials of continental origin increase metal concentrations. (Ence-PTT)
W90-03350

SURVIVAL AND ACTIVITY OF STREPTOCOCCUS FAECALIS AND ESCHERICHIA COLI IN TROPICAL FRESHWATER.
Puerto Rico Univ., Rio Piedras. Dept. of Biology.
For primary bibliographic entry see Field 5A.
W90-03371

PHENANTHRENE MINERALIZATION ALONG A NATURAL SALINITY GRADIENT IN AN URBAN ESTUARY, BOSTON HARBOR, MASSACHUSETTS.
Massachusetts Univ. at Boston. Dept. of Biology.
M. P. Shiaris.
Microbial Ecology MCBEBU, Vol. 18, No. 2, p 135-146, 1989. 3 fig, 1 tab, 47 ref. EPA Grants R-811818-01-0 and R-810119-01-0.

Descriptors: *Fate of pollutants, *Polycyclic aromatic hydrocarbons, *Saline water, *Tidal rivers, *Mineralization, *Phenanthrene, Urban areas, Boston Harbor, Glutamate.

The effect of varying salinity on phenanthrene and glutamate mineralization was examined in sediments along a natural salinity gradient in an urban tidal river. Mineralization was measured by trapping 14CO2 from sediment slurries dosed with trace levels of (14C)phenanthrene or (14C)glutamate. Sediments from three sites representing three salinity regimes (0, 15, and 30%) were mixed with filtered column water from each site. Ambient phenanthrene concentrations were also determined to calculate phenanthrene mineralization rates. Rates of phenanthrene mineralization related significantly to increasing salinity along the transect as determined by linear regression analysis. Rates ranged from 1 ng/hr/g dry sediment at the freshwater site to > 16 ng/hr/g dry sediment at the 30 ppt salinity site. Glutamate mineralization also increased from the freshwater to the marine site; however, the relationship to salinity was not statistically significant. To examine the effect of salinity on mineralizing activities, individual sediments were mixed with filtered water of the other two sites. Slurries were also made with artificial seawater composed of 0, 15, or 30 g NaCl/L to substitute for overlying water. Rates of phenanthrene mineralization in the 0 ppt ambient salinity sediments were not affected by higher salinity waters. Activities in the 15 and 30 ppt ambient salinity sediments, however, were significantly inhibited by incubation with 0 ppt salinity water. The inhibition, in large part, appears to be due to the decreased NaCl concentration of the water phase. Glutamate mineralization was affected in a similar manner, but not as dramatically as phenanthrene mineralization. The results suggest that phenanthrene degraders in low salinity estuarine sediments subject to salt water intrusion are tolerant to a wide range of salinites but phenanthrene degradation in brackish waters is mainly a function of obligate marine microorganisms. (Author's abstract)
W90-03372

TRANSFORMATION OF CHLORINATED PHENOLIC COMPOUNDS IN THE GENUS RHODOCOCCUS.
Helsinki Univ. (Finland). Dept. of General Microbiology.
M. M. Haggblom, D. Janke, and M. S. Salkinoja-Salonen.
Microbial Ecology MCBEBU, Vol. 18, No. 2, p 147-159, 1989. 6 fig, 2 tab, 35 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Bacteria, *Rhodococcus, *Chlorinated hydrocarbons, *Phenols, *Water pollution control, Sludge, Soil bacteria.

The ability of strains of the genus Rhodococcus to transform chlorinated phenolic compounds was studied. Noninduced cells of several strains of Rhodococcus, covering at least eight species, were found to attack monochlorophenols, dichlorophenols, and trichlorophenols by hydroxylation at the

ortho position to chlorocatechols. 3-chlorophenol and 4-chlorophenol were converted to 4-chlorocatechol, 2,3-dichlorophenol to 3,4-dichlorocatechol, and 3,4-dichlorophenol to 4,5-dichlorocatechol. The chlorocatechols accumulated to nearly stoichiometric amounts. Other monochlorophenols and dichlorophenols were not transformed. The ability of the strains to hydroxylate chlorophenols correlated with the ability to grow on unsubstituted phenol as the sole source of carbon and energy. Several Rhodococcus strains attacked chlorophenolic compounds by both hydroxylation and O-methylation. 2,3,4-trichlorophenol, 2,3,5-trichlorophenol, and 3,4,5-trichlorophenol were hydroxylated to trichlorocatechol and then sequentially O-methylated to chloroguaiacol and chloroveratrole. Tetrachlorohydroquinone was O-methylated sequentially to tetrachloro-4-methoxy-phenol and tetrachloro-1,4-dimethoxybenzene. Several of the active strains had no known history of exposure to any chloroaromatic compound. Rhodococci are widely distributed in soil and sludge and these results suggest that this genus may play an important role in transformation of chlorinated phenolic compounds in the environment. (Author's abstract)
W90-03373

RUNOFF, SEDIMENT AND NUTRIENT LOSSES FROM VARIOUS TILLAGE SYSTEMS OF COTTON.
Auburn Univ., AL. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W90-03377

FISHES IN THE ILLINOIS PORTION OF THE UPPER DES PLAINES RIVER.
Southern Illinois Univ., Carbondale. Dept. of Zoology.
R. C. Heidinger.
Transactions of the Illinois Academy of Science TISAAH, Vol. 82, No. 1-2, p 85-96, 1989. 6 tab, 10 ref.

Descriptors: *Wetland restoration, *Wetlands, *Water pollution effects, *Illinois, *Fish populations, *Carp, *Water pollution sources, Des Plaines River, Nonpoint pollution sources, Urban areas, Agricultural runoff, Channeling, Urbanization, Species diversity.

The Des Plaines River Wetlands Demonstration Project is the reconstruction of a riverine wetland on a 182 ha site bordering a 4.67 km stretch of the Upper Des Plaines River. The site is in Wadsowrth, Illinois, 58 km north of Chicago. The river, which drains a 5400 sq km watershed (80% is agricultural and 20% urban), is polluted with nonpoint source contaminants from both urban and agricultural activities. The composition and relative abundance of fish species in the upper portion of the Des Plaines River are reported. Ninety percent of the fish biomass in this section of the river is carp. Standing crop estimates of carp indicate 371 kg/km of river. By almost any measure, the fish habitat in the upper Des Plaines River has been seriously degraded since the pre-settlement era due to channelization, urbanization, and agricultural practices. This has lead to a reduction in or loss of many pollution-sensitive species. (Mertz-PTT)
W90-03385

SIMPLE PREDICTIVE APPROACH TO SOLUTE TRANSPORT IN LAYERED SOILS.
Oxford Univ. (England). Dept. of Plant Sciences.
J. S. Dyson, and R. E. White.
Journal of Soil Science JSSCAH, Vol. 40, No. 3, p 525-542, September 1989. 5 fig, 6 tab, 33 ref.

Descriptors: *Leaching, *Path of pollutants, *Nonpoint pollution sources, *Soil chemistry, *Sand, *Soil columns, *Solute transport, *Nitrates, *Chlorides, Soil physics, Model studies, Traveltime, Transfer function model, Convection-dispersion model.

Solute transport through layered columns (repacked aggregates overlying sand) was studied

under steady flow conditions. Predictions of transport were simplified by assuming that the distribution of solute travel times in one layer was not correlated with that in the other. The implications of this assumption were developed for the transfer function model (TFM) and the convection-dispersion model (CDM) of solute transport. The parameter values in each model were obtained from experiments carried out on columns containing only aggregates or sand. The solutes used were nitrate (surface-applied) and chloride (previously distributed); predictions of the chloride movement were made using the parameter values for the nitrate. The predictions were tested against experimental values of drainage effluent concentration and solute concentration with depths in the columns (measured at the end of the experiments). The TFM (with an assumed lognormal distribution of travel times) and the CDM did not differ significantly, mainly because the spatial scale of the experiments was small. Because the parameter values for the columns of aggregates or sand were determined from the drainage effluent data, they were average values for whole columns. These parameters were satisfactory for predicting drainage effluent concentration from the two-layer columns. However, they were not satisfactory for predicting the depth distribution of solute, particularly in the sand, because the water content of the sand increased with depth, unlike that of the aggregates, which was approximately constant with depth. The overall results of this study on materials of differing transport characteristics suggest that the assumption of uncorrelated travel times between layers has a potentially wide application. The approach taken here needs to be tested on undisturbed layered soils. (Author's abstract)
W90-03408

USABLE MECHANISTIC MODEL OF NITRATE LEACHING: I. THE MODEL.
Imperial Chemical Industries Ltd., Bracknell (England). Plant Protection Div.
D. Barraclough.
Journal of Soil Science JSSCAH, Vol. 40, No. 3, p 543-554, September 1989. 8 fig, 3 tab, 22 ref.

Descriptors: *Nonpoint pollution sources, *Path of pollutants, *Soil physics, *Soil chemistry, *Solute transport, *Nitrates, *Leaching, *Soil water, *Model studies, Simulation, Convection-dispersion, Flow, Rainfall intensity, Mathematical models, Hydraulic conductivity.

A mechanistic model to simulate the leaching of nitrate in soil can accomodate three flow patterns: conventional convective-dispersion; preferential flow, in which water and solute moving in the larger water-filled pores fails to equilibrate with that in the smaller pores; and by-pass flow, in which water (and solute) moves rapidly down cracks and fissures without displacing the soil water. The pattern of flow depends on the rainfall intensity and the hydraulic conductivity of the water-filled pore space. The performance of the model was examined in terms of its ability to reproduce solute profiles calculated from analytical solutions to transport equations, and in the sensitivity of the output to changes in the main parameters. The results suggest that the model, as formulated, is mathematically reliable. In some soils where significant preferential flow is occurring, solute movement may be adequately described if the rate of solute equilibration between the conducting and immobile pore space is rapid compared to flow. (See also W90-03410) (Sand-PTT)
W90-03409

USABLE MECHANISTIC MODEL OF NITRATE LEACHING: II. APPLICATION.
Imperial Chemical Industries Ltd., Bracknell (England). Plant Protection Div.
D. Barraclough.
Journal of Soil Science JSSCAH, Vol. 40, No. 3, p 555-562, September 1989. 5 fig, 2 tab, 9 ref.

Descriptors: *Nonpoint pollution sources, *Path of pollutants, *Soil physics, *Soil chemistry, *Solute transport, *Nitrates, *Leaching, *Soil water, *Model studies, Flow, Simulation.

Simulations produced by a mechanistic model are compared with field observations of nitrate leaching from 0.35 ha hydrologically isolated experimental plots. The parameters used in the model were obtained in two ways. First by fitting the model to field observations in one year. These parameters were then used to simulate leaching in other years. Second, model parameters were obtained by fitting eluant profiles from pulse inputs of solute to undisturbed cores in the laboratory. When used with the field-derived parameters, the model simulates total leaching losses well in other years, although the pattern of loss is only approximately reproduced. The simulation suggests that water and solute flow in drained, structured soils is complex; preferential flow in the upper horizons resulting in 20% of the water-filled pore space carrying most of the solute flow, and by-pass flow in the subsoil causing rapid movement of water and solute to the drains. The result is that much of the nitrate in the upper horizons appears to be protected from leaching. When used with laboratory-derived parameters, the model was a poor predictor of both the pattern and quantity of nitrate leached. (See also W90-03409) (Author's abstract)
W90-03410

DOWNSLOPE MOVEMENT OF CHLORSULFURON AFTER CONVENTIONAL AND OVERSNOW APPLICATIONS TO WINTER WHEAT.
Utah State Univ., Logan. Dept. of Plant Science.
J. B. Asghari, S. A. Dewey, and T. A. Tindall.
Soil Science SOSCAK, Vol. 148, No. 3, p 227-230, September 1989. 1 fig, 2 tab, 5 ref.

Descriptors: *Nonpoint pollution sources, *Path of pollutants, *Herbicides, *Chlorsulfuron, *Surface runoff, *Snow cover, Erosion, Fertilizers, Wheat, Agricultural runoff.

Chlorsulfuron was applied conventionally in the fall and over snow-covered winter wheat in an aqueous suspension with graphite powder and urea ammonium nitrate in February and March to determine downslope herbicide movement in runoff. Plots were established in fields with slopes of 8-14%. Snow depth during winter application ranged from 20-60 cm. Soil samples collected in the spring 0.6, 0.9, 1.5, 2.4, 3.7, 5.2, 7 and 9.1 m downslope from each treated plot were analyzed using a lentil bioassay technique to determine the presence of herbicide. Chlorsulfuron residues were detected as far as 3.7 m downslope from plots. Less downslope herbicide movement occurred when chlorsulfuron was applied with graphite over snow than when applied as a conventional fall treatment. If herbicide is applied over snow without graphite, significant amounts may be lost as a result of erosion. (Author's abstract)
W90-03417

STOCHASTIC ANALYSIS OF NONSTATIONARY SUBSURFACE SOLUTE TRANSPORT: 2. CONDITIONAL MOMENTS.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
W. Graham, and D. McLaughlin.
Water Resources Research WRERAQ, Vol. 25, No. 11, p 2331-2355, November 1989. 13 fig, 3 tab, 57 ref, 2 append. NSF grant ECE-8514987.

Descriptors: *Groundwater pollution, *Pollutant transport, *Path of pollutants, *Solute transport, *Hydraulic conductivity, *Groundwater movement, *Stochastic hydrology, Kalman filter, Advection, Dispersion.

Stochastic analyses of subsurface transport indicate that the concentration distributions of individual solute plumes may deviate significantly from those predicted by unconditional ensemble statistics, particularly in near-source regions. A method is presented for developing improved concentration predictions which are tailored to site-specific conditions. The improved predictions are obtained by conditioning ensemble moments on field observations of log hydraulic conductivity, head, and solute concentration. The conditional moments are obtained from a distributed parameter Kalman filter which is recursively linearized about the most recent estimates of solute concentration and

velocity. The conditioning procedure is illustrated for two synthetic random solute plumes. Reasonably good estimates of the solute concentration distributions were obtained by conditioning the ensemble moments on a small number of measurements located in regions of high concentration uncertainty. The sampling networks adapt to the unique characteristics of each plume as they evolve over time. The example indicates that it is more important to capture the dominant trends of the velocity field at as early a time as possible. As more measurements become available, advection accounts for a greater portion of small-scale velocity variability, and the magnitude of the macrodispersion term diminishes. This is reflected in the behavior of the conditional ensemble moments. (Author's abstract)
W90-03421

UNIDIMENSIONAL SOLUTE TRANSPORT INCORPORATING EQUILIBRIUM AND RATE-LIMITED ISOTHERMS WITH FIRST-ORDER LOSS: 3. APPROXIMATE SIMULATIONS OF THE FRONT PROPAGATING AFTER A STEP INPUT.
Department of Scientific and Industrial Research, Lower Hutt (New Zealand). Inst. of Nuclear Sciences.
K. R. Lassey.
Water Resources Research WRERAQ, Vol. 25, No. 11, p 2357-2366, November 1989. 5 fig, 16 ref, 2 append.

Descriptors: *Groundwater pollution, *Groundwater movement, *Solute transport, *Porous media, *Isotherms, *Model studies, Mathematical models, Simulation.

Sorptive processes which accompany unidimensional solute flow through a porous medium can be modeled in terms of rate-limiting isotherms. Both the rate limitations and dispersive processes combine to degrade or distend an otherwise sharp solute front initially introduced to the 'column' as a step. Whenever dispersion is the dominant distending mechanism, the model simulation can be well approximated by replacement of the isotherm with a local equilibrium assumption (LEA). Conversely, if kinetics dominate distension, the neglect of dispersion can provide an efficacious approximant. The double Laplace-like approximation (DLA) has been developed as a useful approximant when neither of these extremes is realized. The development is for a simulation model of unidimensional dispersive and advective transport which, in its most general form, incorporates combined linear Freundlich and rate-limited isotherms, and first-order loss, as formulated previously. The DLA is about as computationally onerous as the LEA and the nondispersive assumption (NDA). The DLA-predicted gradients of solute and sorbed concentration at the front are related to the Peclet and Damkohler numbers (characteristic of dispersion and kinetics, respectively), and includes as special cases those predicted by the LEA and NDA. A numerical survey of the three approximants indicates that, for a propagating solute front of relatively minor distension, the DLA is the superior approximant. (Author's abstract)
W90-03422

SEASONAL CHANGES OF CADMIUM AND COPPER LEVELS IN STEM-BORING LARVAE OF AGAPANTHIA VILLOSOVIRIDESCENS (COLEOPTERA) ON SALT MARSHES OF THE WESTERSCHELDE ESTUARY.
Delta Inst. for Hydrobiological Research, Yerseke (Netherlands).
M. A. Hemminga, J. Nieuwenhuize, C. H. Poley-Vos, and J. van Soelen.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 5, p 747-754, November 1989. 2 fig, 2 tab, 15 ref.

Descriptors: *Path of pollutants, *Bioaccumulation, *Cadmium, *Copper, *Salt marshes, *Aquatic insects, *Heavy metals, Larvae, Larval growth stage, Estuaries, Seasonal variation, The Netherlands, Path of pollutants.

Analyses of heavy metals in insects, including their developmental stages, have been widely used to monitor the penetration of these pollutants in various ecosystems, or have been carried out in attempts to make ecological generalizations regarding transfer and accumulation along food chains. There are however, few reports dealing with seasonal changes in heavy metal content of insects. In this study, the time course of cadmium and copper concentrations in larvae of the longhorn beetle Agapanthia villosoviridescens was followed. Larvae were collected from three salt marshes along the Westerschelde estuary in The Netherlands, which is severely polluted by heavy metals. Flowering stems of Aster tripolium, which showed circular marks due to ovipository activity of Agapanthia females, were collected periodically from each sampling site from late summer 1986 until spring 1987. Within larval populations, Cd levels were found to fluctuate strongly with time; Cd levels decreased in autumn and winter. This phenomenon was not found for Cu. The variable Cd level is interpreted as being the result of changing environmental conditions in the field during the larval period, i.e. lowering temperatures causing the cessation of feeding activity. (VerNooy-PTT)
W90-03426

SURVEY OF PERSISTENT PESTICIDE RESIDUES IN THE EDIBLE TISSUES OF WILD AND POND-RAISED LOUISIANA CRAYFISH AND THEIR HABITAT.
Louisiana State Univ., Baton Rouge. Dept. of Food Science.
J. D. Madden, M. W. Finerty, and R. M. Grodner.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 5, p 779-784, November 1989. 1 tab, 11 ref.

Descriptors: *Pesticides, *Crayfish, *Tissue analysis, *Crustaceans, *Organic pesticides, *Lake fisheries, *Louisiana, *Path of pollutants, DDE, DDD, Detritus, Bioaccumulation.

Procambarus clarkii and P. acutus acutus crayfish, the two most important species of an economically important crop in southern Louisiana, are commercially harvested from ponds and from waters contiguous with the Atchafalaya River Basin and the Mississippi River. They are known detritivores, which during their feeding may ingest xenobiotic contaminants adsorbed onto decaying vegetation and the sediment. Crayfish abdominal muscle and hepatopancreas, sediments and water collected from four dual-cropped ponds (rice and crayfish) and two Atchafalaya River Basin locations during the 1986 and 1987 production years were analyzed for persistent and organochlorine pesticides. The only pesticide residues detected in occasional tissue samples were DDD and DDE. The relatively high readings (0.311 mg/kg p,p'-DDD detected in the early abdominal muscle pond samples, 0.364 p,p'-DDD in the peak 1987 river basin hepatopancreas, and 0.109 in the late 1987 pond hepatopancreas) were not confirmed on the second column and most likely represent co-eluting artifacts. Neither DDD nor DDE were detected in water or sediment samples. No confirmable quantities of dieldrin, endrin, heptachlor, heptachlor epoxide, or Mirex were detected in any tissue or environmental sample. The small amount of persistent pesticides that may have entered the crayfish from the ingestion of food and sediment or thorough the gills would be readily detoxified by the mixed function oxidase system. From the aspect of human consumption, Louisiana crayfish appear to be relatively free of anthropogenic persistent pesticide residues. (VerNooy-PTT)
W90-03430

ZINC ACCUMULATION IN FIDDLER CRABS UCA ANNULIPES LATREILLE AND UCA TRIANGULARIS (MILNE EDWARDS).
Mississippi Univ. Medical Center, Jackson. Dept. of Neurology.
V. Uma Devi, and Y. Prabhkara Rao.
Ecotoxicology and Environmental Safety EESADV, Vol. 18, No. 2, p 129-140, October 1989. 6 fig, 7 tab, 25 ref.

Descriptors: *Path of pollutants, *Zinc, *Crabs, *Bioaccumulation, *Toxicity, *India, Tissue analysis, Heavy metals, Bioassay.

The effect of exposure time and concentration on the tissue-specific accumulation of Zn in two fiddler crabs, Uca annulipes and Uca triangularis, obtained from polluted (Visakhapatnam Harbor) and unpolluted (Bhimilipatnam) areas in eastern India was studied. Hepatopancreas registered major accumulation of Zn when the crabs were exposed to sublethal concentrations (6.38 to 15.39 ppm) for 30 days. However, when the crabs were exposed to different concentrations of Zn (LC0, LC25, LC50, LC75) ranging from 12.93 to 99.38 ppm, higher accumulation was recorded in gills than in hepatopancreas. There was a progressive increase in the percentage body burden of Zn in hepatopancreas, but that in gills showed a decreasing trend. The standardized body burdens for both species of crabs were calculated to evaluate their sensitivity to exposure time as well as to concentration. The fractional retention coefficients of exposure time estimated for exposed crabs indicate that U. triangularis from Bhimilipatnam, having the highest value, is sensitive and U. annulipes from Visakhapatnam Harbor, showing the lowest value, is resistant. (Author's abstract)
W90-03436

METABOLISMS OF 14C-CARBARYL AND 14C-1-NAPHTHOL IN MOIST AND FLOODED SOILS.
Bhabha Atomic Research Centre, Bombay (India). Nuclear Agriculture Div.
N. B. K. Murthy, and K. Raghu.
Journal of Environmental Science and Health (B) JPFCD2, Vol. 24, No. 5, p 479-491, October 1989. 3 tab, 17 ref.

Descriptors: *Biodegradation, *Carbaryl, *Fate of pollutants, *Insecticides, *Naphthol, Metabolism, Saturated soils, Chemical analysis, Carbon radioisotopes, Mineralization, Soil types.

The metabolisms of 14C-carbaryl and 14C-1-naphthol in moist and flooded soils was studied in a continuous flow-through system over a period of 28 days permitting 14C-mass balance. The percent distribution of radiocarbon in organic volatiles, carbon dioxide, extractable and non-extractable (bound) fractions of soils were determined. Organic volatiles could not be detected in either carbaryl or 1-naphthol treated soils. More of 14CO2 was evolved from moist (25.6%) than flooded soil (15.1%) treated with carbaryl. However, the mineralization of 14C-1-naphthol was negligible. The extractable radiocarbon from carbaryl treatment was greater in flooded soil (28.9%) than moist soil (5.5%). Less than one percent was present as parent compound, whereas carbaryl was mainly metabolized to 5-hydroxy carbaryl in moist soil and to 4-hydroxy and 5-hydroxy carbaryl in flooded soil. The extractable radiocarbon amounted to 18.2 and 24.3% in moist and flooded soils respectively, and the parent compound was less than one percent with 1-naphthol treatment. Most of the radiocarbon was found as soil bound residues; the formation being more common with 1-naphthol than carbaryl. The humin fraction of soil organic matter contributed most to soil bound residues of both carbaryl and 1-naphthol. (Author's abstract)
W90-03444

INCIDENCE OF FAECAL COLIFORM AND ESCHERICHIA COLI IN FRESH FISHERY PRODUCTS.
Cochin Univ. of Science and Technology (India). School of Marine Sciences.
P. Lakshmanaperumalsamy, S. Premjith, and A. Purushothaman.
Bulletin of the Department of Marine Sciences University of Cochin, Vol. 14, p 11-16, 1986-88. 2 fig, 1 tab, 7 ref.

Descriptors: *Path of pollutants, *Coliforms, *Fish, *India, *Estuarine environment, Escherichia coli, Klebsiella.

Finfish from marine and estuarine environment, shellfish, water and sediment samples (total 204) from estuarine environment of the Portonovo coast were screened for the presence of total coliform (TC), faecal coliform (FC) and Escherichia coli (EC). TC, FC and EC were found in 89.7%, 72.5% and 49% of samples respectively. Finfish collected from estuarine environment showed the presence of the above bacterial fractions consistently with higher magnitude than marine counterparts. The incidence was of high level on body surface followed by gill and intestine. The major component of FC was E. coli, followed by Klebsiella. (Author's abstract)
W90-03451

STUDIES ON HYDROCARBON UTILIZING BACTERIA IN COCHIN BACKWATER.
Cochin Univ. of Science and Technology (India). School of Marine Sciences.
K. Nandakumar, M. Chandrasekaran, and P. Lakshmanaperumalsamy.
Bulletin of the Department of Marine Sciences University of Cochin, Vol. 14, p 75-82, 1986-88. 2 fig, 5 tab, 13 ref.

Descriptors: *Biodegradation, *Bacteria, *Hydrocarbons, *Oil spills, *Fate of pollutants, *Backwater, Cochin, Pseudomonas, Vibrio, Micrococcus.

Distribution of hydrocarbon utilizing bacteria (HUB) in water and sediment samples collected from Cochin backwater was studied over a period of six months from December 1982 to May 1983. HUB varied from 1000-10,000/100 ml and 10,000-100,000/g of water and sediment samples respectively. About 90% of these isolates showed various oil utilizing potential. Pseudomonas was the predominant genus followed by Vibrio and Micrococcus. All of the isolates utilized crude oil; most degraded motor oil and gasoline; kerosene was least preferred. Degradation of crude oil, motor oil, and gasoline was fairly constant from December through May, however, kerosene and diesel fuel utilization was highest in December and April. (Author's abstract)
W90-03455

SURFACE-SEDIMENT CHRYSOPHYTES FROM 35 QUEBEC LAKES AND THEIR USEFULNESS IN RECONSTRUCTING LAKE-WATER PH.
Queen's Univ., Kingston (Ontario). Dept. of Biology.
W90-03458

FINDINGS OF TRIBUTYLTIN, DIBUTYLTIN AND MONOBUTYLTIN IN BIVALVES FROM SELECTED U.S. COASTAL WATERS.
Battelle Ocean Sciences, Duxbury, MA.
A. D. Uhler, T. H. Coogan, K. S. Davis, G. S. Durell, and W. G. Steinhauer.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 11, p 971-979, 1989. 3 fig, 3 tab, 24 ref. NOAA Contract No. 50-DGNC-5-00263.

Descriptors: *Metal organic pesticides, *Pesticides, *Antifoulants, *Mollusks, *Coastal waters, *Pollutant identification, Path of pollutants, *Organotin compounds, Chemical analysis, Gas chromatography.

A method is presented for determining trace levels of tributyltin (TBT) and its degradation products dibutyltin (DBT) and monobutyltin (MBT) and the TBT manufacturing impurity tetrabutyltin (TTBT) in bivalve mollusk tissue. In this modification of previous methods, samples were acidified with HCl and derivatized with n-pentylmagnesium bromide. The pentyl derivatives were analyzed by high resolution capillary gas chromatography using a flame photometric detector. Butyltin compounds were analyzed in bivalve mollusk collected from selected near-shore sites of the U.S. east and west coasts. All bivalves from the sites investigated were contaminated with TBT, DBT and, sporadically, MBT. The ratio of TBT/DBT in sential organism tissue appears to be a species-specific equilibrium value, with average values for Mytilus

edulis of 2.5 and Mytilus californianus of 11.6. (Author's abstract)
W90-03459

FATE OF DYES IN AQUATIC SYSTEMS II. SOLUBILITY AND OCTANOL/WATER PARTITION COEFFICIENTS OF DISPERSE DYES.
Georgia Univ., Athens. Dept. of Textiles, Merchandising and Interiors.
C.-P. C. Yen, T. A. Perenich, and G. L. Baughman.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 11, p 981-986, 1989. 1 fig, 1 tab, 14 ref. EPA Grant No. CR812638.

Descriptors: *Dyes, *Fate of pollutants, *Solubility coefficient.

Water solubilities have been measured for 10 disperse dyes that are mostly of recent vintage. The solubilities and octanol/water partition coefficients are used to predict expected concentration factors for sediment and biota. The results show that these newer disperse dyes are likely to have greater potential toward sediment sorption and bioconcentration than older dyes. The data also confirm a previous conclusion that methods for estimating the octanol/water partition coefficient of these dyes give results that are significantly different from measured values. Possible explanations for the difference are: tendency of these dyes to dimerize, as well as errors due to tautomerization, and inaccuracies in entropies of fusion. (Author's abstract)
W90-03460

MODELING THE FATE OF CHEMICALS IN AN AQUATIC ENVIRONMENT: THE USE OF COMPUTER SPREADSHEET AND GRAPHICS SOFTWARE.
Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.
J. M. Southwood, R. C. Harris, and D. Mackay.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 11, p 987-996, 1989. 6 fig, 5 tab, 8 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Computer models, *Model studies, *Aquatic environment, Sediment-water interfaces, Simulation analysis, Organophosphorus compounds, Chloroform.

The Quantitative Water Air Sediment Interaction (QWASI) model, based on the concept of fugacity, is used to develop quantitative descriptions of the fate of chemicals in aquatic environments using LOTUS 1-2-3 software on a microcomputer. This software package is shown to provide a powerful, easy to use framework in which to use QWASI to simulate the reported fate of three chemicals: tertiary butylphenyl diphenyl phosphate, 3,4-dichloroaniline and chloroform. For each chemical, the graphics capabilities and interactive features of LOTUS 1-2-3 are used to guide the modeler regarding the influence of various processes on the fate of the chemical and determine appropriate variables on which to focus to improve the simulation. (Author's abstract)
W90-03461

POLYCHLORINATED DIBENZOFURANS AND POLYCHLORINATED DIBENZO-P-DIOXINS IN GREAT LAKES FISH: A BASELINE AND INTERLAKE COMPARISON.
Environmental Protection Agency, Chicago, IL. Great Lakes National Program Office.
D. De Vault, W. Dunn, P.-A. Bergqvist, K. Wiberg, and C. Rappe.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 11, p 1013-1022, 1989. 6 fig, 5 tab, 27 ref. EPA Grant No. R005854-01.

Descriptors: *Path of pollutants, *Fate of pollutants, *Polychlorinated biphenyls, *Dibenzofurans, *Great Lakes, *Fish, Trout, Comparison studies.

Fish from each of the Great Lakes and Lake St. Clair were analyzed for 10 congeners of polychlorinated dibenzofurans (PCDFs) and 8 congeners of polychlorinated dibenzo-p-dioxins (PCDDs). PCDFs and PCDDs were identified above detection limits in samples from each lake. Concentrations of PCDFs, principally 2,3,7,8-TCDF, were highest (102.4 ng/kg) in Lake Michigan lake trout and lowest in late trout from Lake Superior (20.9 ng/kg). Total PCDD concentrations ranged from 7.2 ng/kg in Lake Superior lake trout in 64.5 ng/kg in Lake Ontario lake trout. Concentrations of 2,3,7,8-TCDD ranged from 1.0 ng/kg in Lake Superior lake trout to 48.9 ng/kg in lake trout from Lake Ontario. While the upper lakes were somewhat similar in the absolute concentration and composition of PCDFs and PCDDs, principle components analysis identified statistically significant inter-lake and intra-lake differences in the composition of total PCDF and total PCDD. These differences suggest differences in the source of these compounds to each of the Great Lakes. (Author's abstract)
W90-03463

BIOAVAILABILITY OF SEDIMENT-SORBED AND AQUEOUS SURFACTANTS TO CHIRONOMUS RIPARIUS (MIDGE).
Procter and Gamble Co., Cincinnati, OH. Ivorydale Technical Center.
C. A. Pittinger, D. M. Woltering, and J. A. Masters.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 11, p 1023-1033, 1989. 4 fig, 3 tab, 25 ref.

Descriptors: *Midges, *Bioavailability, *Linear alkyl sulfonates, *Surfactants, *Toxicity, *Path of pollutants, Sediment-water interfaces, Adsorption.

The bioavailability of sediment-sorbed and soluble fractions of three surfactants were compared in egg hatchability and partial life cycle chronic bioassays with the midge Chironomus riparius. The chemicals tested were linear alkyl (dodecyl) benzene sulfonate (LAS), dodecyl trimethyl ammonium chloride (TMAC) and distearyl dimethyl ammonium chloride (DSDMAC). Midge eggs exposed to ranges of surfactant concentrations in water were monitored for hatching success and posthatch survival. No significant reductions in egg hatching were observed at the highest concentrations tested: 18.9 mg/L LAS, 21.5 mg/L DSDMAC and 15.4 mg/L TMAC. Newly hatched larvae were more sensitive than eggs; respective 72-h LC50 concentrations (48-h for TMAC) were 2.2, 11.3 and 14.6 mg/L. In partial life cycle chronic bioassays in sediment/water test systems, percentages of winged adults emerging after continuous exposure of larvae and pupae to doses of each surfactant were determined. Exposure concentrations in sediment, interstitial water and overlying water were monitored by (14)C liquid scintillation counting. Lowest observed effect concentrations (LOECs) of sediment-spiked surfactants were 319 to 993 micrograms/g (dry weight) LAS, 876 to 2,708 micrograms/g DSDMAC and > 3,084 micrograms/g TMAC (highest concentration tested). Corresponding no observed effect concentrations (NOECs) were 319 micrograms/g LAS, 876 micrograms/g DSDMAC and 3,084 micrograms/g TMAC. The NOECs are approximately 100, 1,000 and 10,000 times greater than respective NOECs of the solubilized materials, and exceed levels of these materials measured in the environment. The results indicated that adsorption onto sediment significantly mitigates surfactant bioavailability to Chironomus. (Author's abstract)
W90-03464

AWWA LEAD INFORMATION SURVEY: A FINAL REPORT.
Black and Veatch, Kansas City, MO.
For primary bibliographic entry see Field 5G.
W90-03469

AIDS TRANSMISSION IN DRINKING WATER: NO THREAT.
California Dept. of Health Services, Berkeley. Viral and Rickettsial Disease Lab.
For primary bibliographic entry see Field 5F.
W90-03470

GIARDIA CYST CONCENTRATIONS IN RIVER WATER.
Washington Univ., Seattle. Dept. of Environmental Health.
J. E. Ongerth.
Journal of the American Water Works Association JAWWA5, Vol. 81, No. 9, p 81-86, September 1989. 5 fig, 3 tab, 12 ref.

Descriptors: *Giardia, *Rivers, *Assay, *Path of pollutants, Pacific Northwest.

Water samples from three pristine rivers in the Pacific Northwest were analyzed for Giardia cyst presence and concentration using a membrane-filtration-immunofluorescence-assay procedure. A total of 222 samples were collected either monthly or bimonthly over a nine-month period from 17 sampling stations on three rivers and 12 tributaries. Cyst recovery efficiency was monitored using samples seeded with cysts at levels ranging from 0.5 to 50 cysts/L. The recovery efficiency of the procedure averaged 21.8% +or-6% through 26 sets of samples. Giardia cysts were found in 94 (43%) of the samples. The corresponding cyst concentrations calculated from the recovery efficiency and the sample volume ranged from 0.1 to 5.2 cysts/L. The distribution of cyst concentrations in positive samples was lognormal. Both the magnitude of cyst concentrations (as indicated by the mean value) and the variability (as indicated by the slope of the distribution) differed among the three rivers. No statistically supportable seasonal variations were found. The principal conclusion was that Giardia cysts appear to be continuously present, though at low concentrations, even in relatively pristine rivers. (Author's abstract)
W90-03472

TRANSPORT OF RIVER-DERIVED TRACE METALS THROUGH THE COASTAL ZONE.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia). Marine Chemistry Div.
J. M. Bewers, and P. A. Yeats.
Netherlands Journal of Sea Research NJSRBA, Vol. 23, No. 4, p 359-368, August 1989. 4 fig, 4 tab, 38 ref.

Descriptors: *Geochemistry, *Heavy metals, *Trace metals, *Coastal waters, Sediment transport, Estuaries, Path of pollutants, Rivers, Model studies, Mixing.

Approaches to estimating the transport of river-derived trace metals through coastal areas, taking account of particle-water exchanges and remobilization from sediments were evaluated. Models of the transport of several trace metals through a semi-enclosed marginal sea and across western North Atlantic continental shelves were used to examine the fluxes of metals through the coastal zone. The relationships between metals and salinity, in both nearshore and offshore areas, were also used to exemplify the consequences of mixing processes in estuaries and to determine apparent riverine end-member compositions on larger spatial scales. In all cases, the metal-salinity extrapolations yielded lower estimates of the net global river fluxes than those calculated from box models of the Gulf of St. Lawrence. A further application of the generic coastal zone model was to quantify the extnet of remobilization of metals from the particulate phase within the coastal zone. The model results clearly demonstrated a redistribution of most of the trace metals from rapidly-settling river borne particles to to the dissolved phase or to smaller particles that settle more slowly. (Author's abstract)
W90-03481

INPUT OF SELECTED CHLORINATED HYDROCARBONS INTO THE COASTAL AREA OF EAST JAVA AND ADJACENT WATERS: DISTRIBUTION PATTERNS IN THE DISSOLVED AND SUSPENDED PHASE.
Nederlands Inst. voor Onderzoek der Zee, Texel.
M. T. J. Hillebrand, J. M. Everaarts, H. Razak, D. Moelyadi Moelyo, and L. Stolwijk.
Netherlands Journal of Sea Research NJSRBA, Vol. 23, No. 4, p 369-377, August 1989. 4 fig, 2 tab,

13 ref.

Descriptors: *Path of pollutants, *Water pollution sources, *Geochemistry, *Indonesia, *Chlorinated hydrocarbons, *Java Sea, *Indian Ocean, Coastal waters, Rivers, DDT, DDD, DDE, Suspended solids.

Selected organochlorines were analyzed in water and suspended particular matter collected at stations in two rivers on East Java, the adjacent coastal zone, the Java Sea and the Indian Ocean. The sampling period covered the dry monsoon and the beginning of the wet monsoon. Concentrations of dissolved polychlorinated biphenyls (PCBs) were in the same range as in Western Europe and North America. In contrast, the concentrations of all measured organochlorines in suspended matter were lower and often not detectable. p,p'-DDT and its metabolites p,p'-DDD and p,p'-DDE showed the highest concentrations of all compounds determined. The rivers Bengawan Solo and Kali Porong can be considered sources of these compounds for the coastal environment, although their impact is restricted to a small area. Significant differences between the dry and wet monsoon were only observed for dissolved PCBs in the river Porong. (Author's abstract)
W90-03482

TRACE OXYANIONS AND THEIR BEHAVIOR IN THE RIVERS PORONG AND SOLO, THE JAVA SEA AND THE ADJACENT INDIAN OCEAN.
Netherlands Energy Research Foundation ECN, Petten.
H. A. Van Der Sloot, D. Hoede, and J. Wijkstra.
Netherlands Journal of Sea Research NJSRBA, Vol. 23, No. 4, p 379-386, August 1989. 5 fig, 4 tab, 20 ref.

Descriptors: *Path of pollutants, *Water pollution sources, *Geochemistry, *Indonesia, *Java Sea, *Indian Ocean, *Heavy metals, *Trace metals, Arsenic, Selenium, Molybdnum, Uranium, Vanadium, Gold, Antimony, Tungsten, Leaching, Volcanic rock, Seasonal variation, River systems.

During the Snellius-II Expedition (theme 5) dissolved and particulate concentrations of As(III), As(V), Sb(III), Se(IV), Mo, U, V, Au and W were measured in the Kali Porong and Bengawan Solo, Strait Madura, the Java Sea and the adjacent Indian Ocean. The estuarine mixing behavior of Mo, U, and V was found to be conservative. Arsenic behaved in a conservative manner during the wet period, while removal was observed in the high salinity region of the Solo and Porong during the dry season. The exceptionally high vanadium concentration in the rivers Porong and Solo, which is more than 10 times higher than that in the world rivers, is connected with leaching of volcanic rock; dissolved concentrations in the Java Sea and in the Indian Ocean compare well with average ocean values. The observed behavior and the concentrations found in the rivers Solo and Porong and the adjacent coastal zone indicates anthropogenic inputs of As, Sb, Se, Mo, U, V, and W are unlikely. (Author's abstract)
W90-03483

DISTRIBUTION OF DISSOLVED AND PARTICULATE MINOR AND MAJOR ELEMENTS IN THE RIVER AND COASTAL ENVIRONMENT OF EAST JAVA DURING THE SNELLIUS-II EXPEDITION.
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 2K.
W90-03484

HEAVY METALS (CU, ZN, CD, PB) IN SEDIMENT OF THE JAVA SEA, ESTUARINE AND COASTAL AREAS OF EAST JAVA AND SOME DEEP-SEA AREAS.
Nederlands Inst. voor Onderzoek der Zee, Texel.
J. M. Everaarts.
Netherlands Journal of Sea Research NJSRBA, Vol. 23, No. 4, p 403-413, August 1989. 7 fig, 2 tab, 20 ref.

Descriptors: *Indonesia, *Path of pollutants, *Water pollution sources, *Geochemistry, *Java, *Heavy metals, *Copper, *Zinc, *Cadmium, Lead, Sediments, Silt, River systems, Estuaries, Coastal waters.

The concentration of copper, zinc, cadmium and lead were measured in the bulk sediment and the silt fraction of the surface sediment (upper 2 cm) from the riverine and estuarine zones of the rivers Brantas and Solo and in the adjacent coastal areas around East Java. The levels of contamination of the sediments with heavy metals were also determined in the Java Sea, some sites in the Bali Sea and the Indian Ocean. The concentrations of the trace elements were consistently higher in the silt fraction than in the bulk sediment. Trace element levels were higher in riverine and estuarine sediments than in sediment from coastal waters and the Java Sea. Increased copper, zinc and cadmium concentrations were measured in surface sediment from deep-sea areas. There were no or only minor differences in the metal concentrations in the sediment (both bulk sediment and the silt fraction) between the dry and the wet monsoon. (Author's abstract)
W90-03485

COPPER, ZINC AND CADMIUM IN BENTHIC ORGANISMS FROM THE JAVA SEA AND ESTUARINE AND COASTAL AREAS AROUND EAST JAVA.
Nederlands Inst. voor Onderzoek der Zee, Texel.
J. M. Everaarts, J. P. Boon, W. Kastoro, C. V. Fischer, and H. Razak.
Netherlands Journal of Sea Research NJSRBA, Vol. 23, No. 4, p 415-426, August 1989. 5 fig, 3 tab, 13 ref.

Descriptors: *Water pollution sources, *Path of pollutants, *Geochemistry, *Bioaccumulation, *Indonesia, *Java, *Java Sea, *Heavy metals, *Aquatic animals, *Benthic fauna, Mollusks, Arthropods, Echinoderms, Fish, Copper, Zinc, Cadmium, Seasonal variation.

A study was made of the concentrations of copper, zinc and cadmium in benthic organisms, representing the phyla Mollusca, Arthropoda, Echinodermata and Pisces, from the riverine and estuarine areas of the rivers Brantas and Solo (East Java) and the adjacent coastal area. Moreover, an assessment was made of the contamination of the benthic biota with these elements in the Java Sea and Bali Sea. Benthic organisms show a species-specific uptake pattern for each element. Compared to the same type of animals from estuaries and coastal areas in temperate regions of western Europe, the concentrations of cadium are considerably higher, while copper and zinc concentrations are somewhat lower. There is in no general trend in concentration levels of the metals in specimens from rivers, estuaries, coastal zone and open sea. In some groups of organisms (e.g. shrimp, starfish) the concentrations of copper and zinc are highest in specimens from rivers and estuaries. In contrast, cadmium concentration levels in e.g. crab, shrimp and squid are lowest in the riverine and estuarine areas. Significant differences in metal concentrations in these organisms were found between the dry monsoon period (July, August) and the beginning of the wet monsoon (November, December). No relationship existed between the metal concentration of the organisms and the silt fraction of the sediment (grain size < 63 microm) or the bulk sediment. (Author's abstract)
W90-03486

CYCLIC ORGANOCHLORINES IN EPIBENTHIC ORGANISMS FROM COASTAL WATERS AROUND EAST JAVA.
Nederlands Inst. voor Onderzoek der Zee, Texel.
J. P. Boon, J. M. Everaarts, W. W. Kastoro, H. Razak, and I. Sumanta.
Netherlands Journal of Sea Research NJSRBA, Vol. 23, No. 4, p 427-439, August 1989. 4 fig, 3 tab, 18 ref.

Descriptors: *Water pollution sources, *Path of pollutants, *Fate of pollutants, *Indonesia, *Polychlorinated biphenyls, *Pesticides, *Benthic fauna,

*Java Sea, DDE, Seasonal variation, Brantas River, Solo River, Porong River.

Polychlorinated biphenyls (PCBs), organochlorine pesticides and their persistent metabolites were identified in epibenthic animals from the estuaries of the rivers Brantas and Solo and from Strait Madura, Strait Bali and the Java Sea in July and November 1984. Samples of different phyla showed similar general geographical trends for the compounds investigated. Contamination with p,p'-DDE was of major importance in the river Porong, a distribution of the Brantas river system. Increased concentrations of PCBs were found near Surabaya. In Strait Madura, p,p'-DDE and PCBs were increased only in animals from the western part. Therefore the dispersion of the contaminants in biota appeared to be determined by the residual currents caused by the SE trade winds prevailing in both periods of sampling (July and November 1984). Generally no differences existed between the two sampling periods, except in the Java Sea, where PCBs were only detected during the November cruise. Compared to the animals from Strait Madura, the PCB patterns showed increased contributions of trichlorobiphenyls and tetrachlorobiphenyls. This could not be related to differences in PCB-patterns of water or suspended particles. The compounds QCB, HCB, alpha-HCH, b-HCH, o,p'-DDD, methoxychlor and several cyclodienes were generally below detection limits. (Author's abstract)
W90-03487

TRANSPORT OF HEAVY METALS DURING FLOOD EVENTS IN THE POLLUTED RIVER GEUL (THE NETHERLANDS).
Utrecht Rijksuniversiteit (Netherlands).
J. Leenaers.
Hydrological Processes HYPRE3, Vol. 3, No. 4, p. 325-338, October-December 1989. 6 fig, 7 tab, 28 ref.

Descriptors: *Heavy metals, *Path of pollutants, *Geul River, *Flood discharge, *Sediment transport, Lead, Zinc, Cadmium, Flood peak, River sediments, The Netherlands, Solute transport, Mass transport.

For a specific flood on the polluted Geul River in the Netherlands in March 1988, the relationships between river discharge, sediment concentrations, and associated metal levels were investigated. It was found that river discharge has only a limited influence on the transport of sediment and lead, zinc, and cadmium. During flood peaks its role is prominent, but at the intermediate stages between peaks, the quantity and quality of transported sediment depend on the variable activity of various sediment sources upstream. Nevertheless, when data from more floods in the Geul River were assembled, sediment and metal rating curves were obtained, which provided correlation coefficients of 0.63-0.92. Using these curves, mass transport calculations were carried out which demonstrate that the bulk of the annual transport of sediments and heavy metals occurs during a limited number of major floods. During these major floods, the dissolved fractions of Pb and Zn accounted for < 5% of the total transport, whereas 23% of Cd is transported in a dissolved state. (Author's abstract)
W90-03501

LABORATORY TEST OF THE SOIL CHEMICAL SUBMODELS OF TWO MODELS OF CATCHMENT ACIDIFICATION.
Stirling Univ. (Scotland). Dept. of Environmental Science.
I. C. Grieve.
Hydrological Processes HYPRE3, Vol. 3, No. 4, p. 339-346, October-December 1989. 2 fig, 14 ref.

Descriptors: *Aluminum, *Acid rain effects, *Model studies, *Laboratory models, *Water pollution sources, Catchment basins, Soil chemistry, Acidification, Ion exchange, Organic soils.

Parameters for ion exchange selectivity and aluminum hydroxide dissolution in the soil chemical submodels used in applications of the Birkenes

model and of MAGIC were compared and several discrepancies identified for organic soils. A laboratory column simulation of the soil chemical submodels was applied to soils from the Loch Dee area in Galloway. Experimental results were well predicted by a simplified version of MAGIC, with ion exchange selectivity parameters similar to those used in a previous simulation of one subcatchment of Loch Dee. The aluminum hydroxide dissolution parameter used previously was found to be too low for the organic soil materials, where a value of 1,000,000 predicted the experimental results more closely. This indicates the necessity to reappraise the processes controlling Al release from acid peats. The model developed also included a simple silicate weathering reaction to release base cations into the system. It is concluded that such simple laboratory simulations are useful for independent calibration of the soil chemical submodel of catchment models. (Author's abstract)
W90-03502

TRANSFORMATION AND EXPORT OF PHOSPHORUS FROM WETLANDS.
Ontario Ministry of the Environment, Thunder Bay (Ontario).
For primary bibliographic entry see Field 2H.
W90-03504

5C. Effects Of Pollution

EXAMINATION OF POTENTIAL RISKS FROM EXPOSURE TO DIOXIN IN PAPER MILL SLUDGE USED TO RECLAIM ABANDONED APPALACHIAN COAL MINES.
Envirologic Data, Inc., Portland, ME.
R. E. Keenan, M. M. Sauer, and F. H. Lawrence.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 1131-1138, 1989. 1 tab, 60 ref.

Descriptors: *Water pollution effects, *Public health, *Human pathology, *Mine reclamation, *Sludge disposal, *Waste disposal, *Dioxins, *Pulp wastes, *Coal mines, *Mine wastes, Risks, Sludge, Wastewater treatment, Wastewater renovation.

The potential human health risks associated with trace concentrations of TCDD equivalents in a pulp and paper mill wastewater treatment plant sludge used in the reclamation of abandoned Appalachian coal mines were assessed. Maximum hypothetical exposures to sludge-containing trace concentrations of TCDD equivalents were estimated to result in insignificant health risks to those who might reside on the reclaimed mine site or use the land to hunt or to graze livestock, for a full lifetime exposure. Concentrations of TCDD equivalents in sludge below 310 ppt present no significant threat to human health under a combination of all the exposure pathways examined in this analysis. It is believed that even higher levels would not present a significant risk, given the conservative exposure modeling performed in this analysis and the selection of a very conservative level of acceptable risk. (Author's abstract)
W90-02615

ACUTE AND CHRONIC TOXICITY OF PRODUCED WATER FROM A NORTH SEA OIL PRODUCTION PLATFORM TO THE CALANOID COPEPOD ACARTIA TONSA.
Shell Research Ltd., Sittingbourne (England). Sittingbourne Research Centre.
A. E. Girling.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 2, p 280-286, 1989. 3 fig, 2 tab, 9 ref.

Descriptors: *Water pollution sources, *Toxicity, *Oil pollution, *Offshore platforms, *Water pollution effects, *Population exposure, *Marine animals, Copepods, Oil wastes.

The routine operation of offshore oil production platforms results in the discharge to the sea of 'produced water' after it has been separated from oil drawn from the reservoir. Discharge of produced water in the U.K. sector of the North Sea is given an exemption from the provisions of the 1971

Prevention of Oil Pollution Act providing the monthly average oil-in-water content measured twice per day does not exceed 40 mg/kg. The methods used to assess acute and chronic toxicity to the marine calanoid copepod Acartia tonsa, and the results of tests performed on a sample of produced water collected in February, 1986 are presented. Tests were performed on subsamples of the bulk sample that were untreated, filtered, or biodegraded. Results showed that exposure to concentrations of 1 and 5% of filtered produced water resulted in adult populations declining to below starting densities after 21 day. In contrast, adult populations increased in all of the 0.5 to 15% concentrations of filtered, biodegraded produced water over the same period. Produced water from the Shell/Esso Dunlin 'A' platform has no acute (48-hr) or chronic (21-day) toxicity to A. tonsa at dilution in the receiving environment greater than 40 and 200-fold, respectively. (Friedmann-PTT)
W90-02620

EFFECT OF SPECIATION ON UPTAKE AND TOXICITY OF CADMIUM TO SHRIMP CRANGON CRANGON (L).
Technical Univ. of Lisbon (Portugal). Centre of Structural Chemistry.
M. L. S. Simoes Goncalves, M. F. C. Vilhena, L. M. V. Machado, C. M. R. Pescada, and M. Legrand de Moura.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 2, p 287-294, 1989. 3 tab, 8 ref.

Descriptors: *Toxicity, *Chemical speciation, *Water pollution effects, *Toxicity, *Absorption, *Cadmium, *Shrimp, Crustaceans, Heavy metals, Trace elements, Bioaccumulation, Population exposure.

A study was conducted on the effects of speciation of cadmium in sea water on toxicity to shrimp Crangon crangon (L) in the presence and absence of pyridine-2,6-dicarboxylic acid (a rough model of a chelate group of humic acids). Ultrafiltration and ion exchange Chelex columns were used in conjuction with atomic absorption (AA) and differential pulse anodic stripping voltammetry (DPASV). The uptake and toxicity of cadmium were studied and the organs where this heavy metal accumulated were noted. It was found that the cadmium complex with pyridine-2,6-dicarboxylic was not available to the shrimp and that during the 5 days of the experimental run, cadmium was preferentially accumulated in the hepatopancreas and carapace. Movement and time of response to external stimuli were affected in the shrimp contaminated with a total cadmium concentration of 0.000006 m. (Freidman-PTT)
W90-02621

NITRITE-INDUCED ANEMIA IN CHANNEL CATFISH, ICTALURUS PUNCTATUS RAFINESQUE.
Delta Branch Experiment Station, Stoneville, MS.
C. S. Tucker, R. Francis-Floyd, and M. H. Beleau.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 2, p 295-301, 1989. 1 fig, 1 tab, 16 ref. Dept. of Agriculture Agreement 84-CSRS-2-2363.

Descriptors: *Water pollution effects, *Toxicity, *Fish populations, *Catfish, *Nitrites, Morbidity, Pathology, Animal pathology, Aquaculture, Population exposure.

Environmental nitrite-nitrogen concentrations of 4 mg/L or more occur sporadically in channel catfish culture ponds, and the frequency of occurrence is greatest in the fall and spring. It is shown that a variable, but generally mild, anemia develops in channel catfish exposed to nitrite. The anemia that develops in the nitrite-exposed fish is thought to be related to the high energy requirement for methemoglobin reduction. Fish were held in test tanks for 7 days before the initial sampling. Six fish were removed from each tank after 7, 14, and 21 days of exposure to nitrite-nitrogen, and blood was collected and analyzed for hematocrit, total hemoglobin, and percent methemoglobin. The development of both methemoglobinemia and

anemia caused a marked reduction in functional hemoglobin in fish exposed to the two highest nitrite concentrations, 2.88 and 1.89 mg/L. On days 7 and 14, blood from fish exposed to 2.88 mg/L nitrite-nitrogen averaged less than 30% of the functional hemoglobin content of control fish. A management procedure for preventing the development of anemia during periods of elevated environmental nitrite concentrations is presented. Increasing the amount of chloride salt added to commercial catfish ponds to obtain a nitrite:chloride molar ratio of about 0.1 or less is recommended to maintain functional hemoglobin at near normal levels. (Friedmann-PTT)
W90-02622

TOXICITY OF THE ORGANOPHOSPHOROUS INSECTICIDE METAMIDOPHOS (O,S-DEMETHYL PHOSPHORAMIDOTHIOATE) TO LARVAE OF THE FRESHWATER PRAWN MACROBRACHIUM ROSENBERGII (DE MAN) AND THE BLUE SHRIMP PENAEUS STYLIROSTRIS STIMPSON.
Instituto Tecnologico y de Estudios Superiores de Monterrey (Mexico). Escuela de Ciencias Maritimas y Alimentaries.
L. M. Juarez, and J. Sanchez.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 2, p 302-309, 1989. 1 fig, 2 tab, 13 ref.

Descriptors: *Water pollution effects, *Toxicity, *Larvae, *Organophosphorus pesticides, *Crustaceans, Aquatic populations, Organophosphorus compounds, Population exposure, Agricultural chemicals, Tropical regions.

The organophosphorous insecticide O,S-dimethyl phosphoramidothioate (Metamidophos, Tamaron, Monitor, Hamidop) is widely used for pest control in tropical crops. If washed down to streams and estuaries, its residues could adversely affect populations of commercially important crustaceans. The toxicity of Metamidophos to larvae of Macrobrachium rosenbergii and Penaeus stylirostris were determined. For P. stylirostris larvae, that Nauplii showed the greatest sensitivity to insecticide, with a 24-h LC50 of 10 ng/L, followed by protozoa and mysis larvae, with 24-hr LC50s of 85 and 160 ng/L, respectively. For M. rosenbergii, Zoea IV and VII were extremely sensitive to the pesticide, with 24-hr LC50s of 0.48 and 0.50 ng/L, respectively. Zoea I and early postlarvae were more resistant, with 24-hr LC50s of 24 and 42 ng/L, respectively. In tests with M. rosenbergii through its complete larval cycle, increasing concentrations of Metamidophos reduced survival and slowed development. The pesticide was, overall, more toxic to crustaceans than other insecticides previously tested. The low LC50 values found in this study and the fact that concentraions as low as 0.10 ng/L can reduce survival and increase time to metamorphosis showed that even small quantities of this pesticide could adversely affect crustacean populations. (Friedman-PTT)
W90-02623

LEAD-INDUCED BIOCHEMICAL CHANGES IN FRESHWATER FISH OREOCHROMIS MOSSAMBICUS.
National Inst. of Occupational Health, Ahmedabad (India).
S. G. Ruparelia, Y. Verma, N. S . Mehta, and S. R. Salyed.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 2, p 310-314, 1989. 1 tab, 14 ref.

Descriptors: *Water pollution effects, *Lead, *Toxicity, *Morbidity, *Fish physiology, Pathology, Population exposure, India, Heavy metals, Trace elements.

In fish, lead is known to cause a variety of effects such as anemia, inhibition of delta-amino levulinic acid dehydratase (ALA-D) activity, caudal fin degeneration and black tail disease. The effect of lead on plasma chemistry was examined in freshwater fish Oreochromis mossambicus. This fish was selected because of its wide availability, its use as a

food fish in India and its suitability as a model fish for toxicity testing. Sixty fish of both sexes, divided into dosed and control groups, were collected from the local pond and acclimatized to laboratory conditions for 14 days prior to the experiment. Lead (as lead acetate) was dissolved in 100 L of aquarium water to achieve the nominal concentrations of 18.0, 24.0, and 33.0 mg Pb(2+)/L. Plasma glucose levels decreased from the controls in fish exposed to all three concentrations. This decrease was significant in the fish exposed to 24.0 and 33.0 mg/L of lead after 14 and 21 days. Thus, lead exposure caused hypoglycemia in fish. This hypoglycemic response might be due to the lead-induced morphological and functional changes in renal tubule cells of the kidney along with reduced gluconeogenesis. Plasma cholesterol level registered a fall from the controls in fish exposed to all three concentrations, with the decrease being significant after 14 days at 33.0 mg/L lead concentration. The fish exposed to various concentrations of lead thus manifested hypocholesterolemia. (Friedmann-PTT)
W90-02624

HEMOGLOBIN AND HEMATOCRIT VALUES IN THE FISH OREOCHROMIS MOSSAMBICUS (PETERS) AFTER SHORT TERM EXPOSURE TO COPPER AND MERCURY.
Cochin Univ. (India). Dept. of Marine Sciences.
P. J. Cyriac, A. Antony, and P. N. K. Nambisan.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 2, p 315-320, 1989. 2 tab, 20 ref.

Descriptors: *Water pollution effects, *Copper, *Mercury, *Toxicity, *Fish physiology, Heavy metals, Trace elements, Population exposure, Morbidity, Sublethal effects.

Hematology is used as an index of health status in a number of fish species. Hematocrit and hemoglobin (Hb) values in the fish Oreochromis mossambicus, separately exposed to two different sublethal concentrations of mercury and copper for a period of 168 h, were determined. Copper concentrations used were 100 micrograms/L and 200 micrograms/L, while mercury concentrations were 100 micrograms/L and 150 micrograms/L. Results showed that the Hb values of copper dosed fish were significantly lower than the controls at 24 h. Mercury dosed fish did not show any significant difference in Hb content. At 72 h, the copper-exposed fishes showed a different trend in Hb values. A highly significant increase in the Hb content of copper-treated fishes was seen at 72 h, but there was no statistical difference in the Hb values for mercury-dosed fish at 24 h and 72 h. The Hb content increased significantly in the copper and mercury-dosed fish at 120 and 168 h. Hematocrit values did not alter significantly in all metal-treated fish at 24 h; at 72 h, the copper-treated fish and fish exposed to the higher concentrations (150 micrograms/L) of mercury showed a statistical increase in hematocrit values. At 120 and 168 h, the hematocrit increased in all metal-treated fish compared to the controls. The increase in hematocrit corresponding with an increase in Hb in both the copper and mercury-exposed fish could have been due to an increased production by the erythropoietic organs. The increased Hb content in the exposed fish could be explained as a process whereby the body produces an increased amount of Hb to replace the oxidized or denatured Hb formed as a result of the metal exposure. (Friedmann-PTT)
W90-02625

EFFECT OF ZINC EXPOSURE ON SUBSEQUENT ACUTE TOLERANCE TO HEAVY METALS IN RAINBOW TROUT.
Anambra State Univ. of Technology, Abakaliki (Nigeria). Dept. of Animal Production and Aquaculture.
D. I. Anadu, G. A. Chapman, L. R. Curtis, and R. A. Tubb.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 3, p 329-336, 1989. 5 tab, 12 ref.

Descriptors: *Water pollution effects, *Sublethal effects, *Zinc, *Trout, Heavy metals, Trace elements, Toxicity, Population exposure, Tolerance.

Fish usually show increased tolerance to metals in solution if previously given an opportunity ot acclimate to near lethal concentrations of the metal. The potential for increased tolerance in rainbow trout (Oncorhynchus mykiss) to zinc was investigated. Results of tests performed to evaluate the relationship between acclimation time and tolerance indicated a very rapid development of zinc tolerance that remained reasonably stable throughout the 28-d acclimation period. Near-maximal tolerance was seen after a 3-d acclimation, and the magnitude of increase in tolerance was only 2 to 3 fold. Increase in tissue metallothionein (MT) levels in livers of acclimated fish was consistent, but the magnitude of increase was less than the increase in tolerance. The influence of only 1 or 2-d acclimation showed no increase in tolerance, and suggested that such short-term acclimation might result in decreased tolerance to zinc. Acclimation at 100 micrograms/L produced nearly a 5-fold increase in tolerance after 9 d, but further acclimation to 100, 300, and then 500 micrograms Zn/L for up to a total of 37 d produced no further increase. Also, following a 17-d acclimation at 100 micrograms/L, tests indicated similar increases to Zn (3.6), Cu (4.7) and Cd (3.7). Metal tolerance probably has several components, including influences on uptake, sequestering, and excretion. (Friedmann-PTT)
W90-02626

PRELIMINARY INVESTIGATION OF PROTEIN UTILIZATION BY AN AQUATIC EARTHWORM IN RESPONSE TO SUBLETHAL STRESS.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
T. J. Keilty, and G. R. Stehly.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 3, p 350-354, 1989. 1 fig, 1 tab, 8 ref.

Descriptors: *Pesticides, *Water pollution effects, *Sublethal effects, *Sediments, *Oligochaetes, *Bioassay, Soil contamination, Aquatic animals, Animal physiology, Endrin, Lake Michigan.

Acute and sub-acute sediment bioassays using endrin-contaminated Great Lakes sediments and the aquatic earthworm, Stylodrilus heringianus, were conducted. The relationship of total protein to dry body weight was used as an indicator of sublethal stress. Sediments and worms were collected in Lake Michigan, approximately 10 km offshore from St. Joseph, Michigan, in 42 m of water. It was found that protein levels (% protein) in oligochaetes from endrin-spiked sediments did not significantly change over the 69-d test period. Body dry weights of worms in the contaminated sediment did, however, decrease with prolonged exposure. Because of this reduction in body weight, the relative percent of protein significantly increased with exposure. This suggests that other potential energy sources (most likely lipid material) were being utilized. Sublethal responses to endrin-contaminated sediments can be monitored by changes in percentage of protein in control vs. endrin-exposed worms or by worm body weight. The measure of total protein does not appear to be as useful in this regard. It does, however, provide insight into the biochemical mechanisms of metabolism under stressful conditions. (Friedmann-PTT)
W90-02629

CHRONIC TOXICITY OF BIPHENYL TO DAPHNIA MAGNA STRAUS.
Dow Chemical Co., Midland, MI. Health and Environmental Sciences.
F. M. Gersich, E. A. Bartlett, P. G. Murphy, and D. P. Milazzo.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 3, p 355-362, 1989. 4 tab, 11 ref.

Descriptors: *Water pollution effects, *Daphnia, *Toxicity, *Chemical wastewater, Crustaceans,

Lethal limit, Industrial wastewater, Aquatic animals.

Biphenyl is used primarily to produce dye carriers, heat-transfer fluids and alkylated biphenyls. Because of the potential for biphenyl to produce chronic effects on aquatic vertebrates and invertebrates when released through wastewater discharge, the U.S. E.P.A. has required chronic daphnid toxicity data for biphenyl. The chronic toxicity of biphenyl to Daphnia magna was determined. The toxicity test was designed to estimate the maximum acceptable toxicant concentration (MATC). All analyzed concentrations were within a range of 63.3 to 97.6% of nominal. The calculated 48-h LC50 value for biphenyl was 0.36 mg/L. During the 48-h test, the no observable effect level was 0.04 mg/L and the 100% kill concentration was > 0.96 mg/L. There was no mortality in the acetone controls and 3% mortality in the water controls over the 48-hr test period. Interpretation of the chronic data indicated that the MATC lies between 0.17 and 0.32 mg/L and is 0.23 mg/L expressed as the geometric mean of these two concentrations. The no observed effect concentration was 0.17 mg/L. Based on the acute/chronic ratio calculated for biphenyl, it would be unlikely to observe chronic invertebrate effects much below levels that are acutely toxic. (Friedmann-PTT)
W90-02630

FACTORS INFLUENCING THIOCYANATE TOXICITY IN RAINBOW TROUT SALMO GAIRDNERI.
Alberta Environmental Centre, Vegreville.
T. A. Heming, and K. A. Blumhagen.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 3, p 363-369, 1989. 4 tab, 9 ref.

Descriptors: *Water pollution effects, *Trout, *Toxicity, *Bioaccumulation, *Thiocyanate, *Fish behavior, Chlorides, Organic compounds, Mortality.

The accumulation and toxicity of SCN(-) (Thiocyanate) in rainbow trout (Salmo gairdneri), in relation to exercise stress and ambient water quality, was studied. The effect of a single bout of exercise on blood SCN(-) concentration was measured. In addition, effects of water hardness and Cl(-) concentration on the accumulation of SCN(-) in blood were determined. To assess the effects of exercise, the fish were chased with a hand-held dipnet and forced to swim vigorously for 30 s at 96 h into the test. Mortality counts were repeated 1 h later (97 h into the bioassay). The 96-h LC50 of SCN(-) for unstressed rainbow trout was greater than 94 mg/L SCN(-). The observed mortalities of unstressed fish were sporadic and without an apparent exposure relationship. A single, 30 sec. bout of strenuous exercise at 96 h was effective to induce 'sudden death' in rainbow trout exposed to > or = 25 mg/L SCN(=). The syndrome signs included tonic convulsions and immediate postexercise loss of equilibrium and buoyancy. At any given water SCN(-) concentration, the 96-h blood SCN(-) concentration was inversely related to the water Cl(-) concentration. SCN(-) completes with other anions, particularly chloride, for uptake across the fish gills. In this study, Cl(-) at concentrations > or = 23 mg/L (two times the molar equivalent of SCN(-)) abolished SCN(-) accumulation at exposure concentrations < or = 15 mg/L SCN(-). At 100 mg/L SCN(-), Cl(-) at concentrations of > or = 125 mg/L reduced SCN(-) accumulation by almost 95%. Thus, it appears that ambient Cl(-) protects fish from SCN(-) toxicity, including 'sudden death syndrome.' (Friedmann-PTT)
W90-02631

MORPHOLOGICAL AND BEHAVIORAL CHARACTERS IN MOSQUITOFISH AS POTENTIAL BIOINDICATION OF EXPOSURE TO KRAFT MILL EFFLUENT.
University of West Florida, Pensacola. Dept. of Biology.
S. A. Bortone, W. P. Davis, and C. M. Bundrick.

Group 5C—Effects Of Pollution

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 3, p 370-377, 1989. 2 tab, 15 ref.

Descriptors: *Water pollution effects, *Bioindicators, *Industrial wastewater, *Fish behavior, *Pulp wastes, *Kraft mills, *Population exposure, Toxicity, Bioassay, Wastewater pollution, Mosquitofish.

Intersexuality in the form of arrhenoidy, induced by environmental factors, is documented for the mosquitofish, Gambusia affinis. The masculinized condition of the secondary sex characteristics (chiefly the anal fin) among female mosquitofish occurs in stream sections receiving kraft mill effluent (KME), but is entirely absent both upstream of the effluent discharge and in tributaries to the main stream. The morphological and behavioral responses of mosquitofish environmentally exposed to KME were investigated, and the potential of these responses as bioassay endpoints was evaluated. Specimens for the behavioral comparison and the evaluation consisted of four treatment groups: males and females from water that had received KME, and males and females from a drainage pond receiving no KME. Twenty replicate pairs of fish from the four treatment groups were observed for 10 min periods, during which they were scored for the frequency of occurrence of five behavioral characters: approach, chase, display, thrust of an erect anal fin toward the gonopore of the other fish, and penetration of the gonopore with an erect or extended anal fin. Results showed that there was no significant tendency for KME-exposed females to have a significantly higher number of behavioral responses than non-KME exposed females. There was, however, an indication that KME-exposed females were statistically similar to males for the behavioral character of Display. There was a slight tendency for non-KME males to show the behavioral characters more frequently than the KME exposed males. Non-KME exposed males tended to show the highest frequency of behavioral characters of all pairwise combinations when interacting with non-KME exposed females. The behavioral characters were ineffective as a measure of bioassay endpoint to distinguish between the treatment groups. (Friedmann-PTT)
W90-02632

RESPONSES AND LC50 VALUES FOR SELECTED MICROCRUSTACEANS EXPOSED TO SPARTAN, MALATHION, SONAR, WEEDTRINE-D, AND OUST PESTICIDES.
Southern Univ., Baton Rouge, LA. Dept. of Biological Sciences.
S. M. Naqvi, and R. H. Hawkins.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 3, p 386-393, 1989. 2 tab, 14 ref. NIH grants 8125 and 8135.

Descriptors: *Water pollution effects, *Organic pesticides, *Crustaceans, *Pesticides, *Bioassay, *Toxicity, Mortality, Herbicides.

Toxicities of Thiodan, Spartan, Malathion, Sonar, Weedtrine, and Oust, organic, agricultural pesticides/herbicides, were assessed via short-term 48-h static bioassays, and their LC50 values were established using microcrustaceans, including Diaptomus and Eucyclops species, collected from Lake Kernan, on the Southern University campus, Baton Rouge, Louisiana, as indicators. During acclimatization, the mortality rate for microcrustaceans did not exceed 10%. During testing, mortalities of control organisms did not exceed 8.7%. The LC50 values for Sonar, tested against Diaptomus, Eucyclops, Alonella, and Cypria, were 12.0, 8.0, 13.0, and 13.0 mg/L, respectively. In the same order, these values for Oust were 1315, 1320, 802, and 2241 mg/L. Thiodan, Malathion and Spartan were much more toxic than the other three compounds. Eucyclops were most susceptible to Thiodan, Malathion and Sonar, while Cypria were more susceptible to Oust. Otherwise, the four genera of microcrustaceans exposed had similar susceptibilities to each pesticide. (Friedmann-PTT)
W90-02633

EFFECTS OF DIFFERENT DILUTION WATER TYPES ON THE ACUTE TOXICITY TO JUVE-

NILE PACIFIC SALMONIDS AND RAINBOW TROUT OF GLYPHOSATE AND ITS FORMULATED PRODUCTS.
Environmental Protection Service, West Vancouver (British Columbia). Pacific and Yukon Region.
M. T. Wan, R. G. Watts, and D. J. Moul.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 3, p 378-385, 1989. 5 tab, 13 ref.

Descriptors: *Water pollution effects, *Toxicity, *Herbicides, Trout, *Mortality, Agricultural chemicals, Salmon, Glyphosate.

The effects of reconstituted water and four natural sources of dilution water were compared for their effects on the acute toxicity to juvenile Pacific salmonids and rainbow trout of glyphosate and its formula products, Roundup, MON 8709 (a new formulation of glyphosate), and their surfactant, MON 0818. A series of 96-h static acute toxicity tests was conducted using 5 species of juvenile salmonids. The cumulative fish mortality was recorded and the LC50 values were calculated using the 'lethal' computer program. The results showed that the LC50 values not only varied, but also changed considerably during the 96-h of exposure for the different materials tested in different dilution water types. Glyphosate appeared to have the least stability within the 96-h test period. Between fish species, glyphosate was the most toxic to chum and rainbow trout in soft water, least toxic to chinook in hard water, and equally toxic to the fish in intermediate water types (reconstituted, well). MON 0818 is most toxic to pink and chum in hard water, and least toxic to coho in soft water. MON 8709 is most toxic to rainbow trout in hard water and least toxic to chinook in soft water types. This product is also similarly toxic to fish in intermediate water. Roundup is most toxic to chum in hard water, and least toxic to coho in intermediate water type, and to chinook, pink and rainbow trout in soft water. Of the formulated products, MON 8709 is significantly more toxic to salmonids in reconstituted water than soft water, but not similar (well) water and hard (lake) water types. Roundup toxicity to salmonids (96-h LC50 20 mg Roundup/ L) in reconstituted water is not significantly different to test results of the other water types. (Friedmann-PTT)
W90-02634

EFFECTS OF BOREHOLE WELLS ON WATER UTILIZATION IN SCHISTOSOMA HAEMATOBIUM ENDEMIC COMMUNITIES IN COAST PROVINCE, KENYA.
Cornell Univ., Ithaca, NY.
For primary bibliographic entry see Field 5F.
W90-02652

LACK OF STRESS-INDUCED NEUROENDOCRINE CHANGES AFTER PROLONGED DRINKING OF ACID WATER IN THE RAT.
Catholic Univ. of the Sacred Heart, Rome (Italy). Dept. of Pharmacology.
P. Preziosi, M. Vacca, R. Del Carmine, E. Ragazzoni, and A. Nunziata.
Archives of Toxicology (Supplement) ATSUDG, No. 13, p 448-451, 1989. 3 fig, 10 ref.

Descriptors: *Acidic water, *Water pollution effects, *Toxicity, *Acid rain, Sulfuric acid, Nitric acid, Animal physiology.

Concern regarding acid rain led researchers to study the effect of one month's daily consumption of acid drinking water, mimicking acid rain, in still-growing male and female Wistar rats. The rats drank a mixture of sulfuric and nitric acid (pH 2.73 +/-0.26) daily, and the effects on blood stress hormones and hypothalamic catecholamines were measured. No changes in behavior, body weight, hematology, blood chemistry, urine analysis or food intake were observed in the rats drinking acidic water. A transient decrease of 8% in drinking water consumption was noticed. Plasma B, serum prolactin, hypothalamic catecholamines and plasma catecholamines were not modified by prolonged administration of acid drinking water. Researchers conclude that damage to aquatic organisms observed in water acidification may not be

found in terrestrial organisms following oral consumption of acid water. Indirect adverse effects on human health may be due to inadvertent consumption of elements in water leached from soil and rocks due to acidity. (Male-PTT)
W90-02655

PROBABILISTIC VALIDATION OF COMPUTER SIMULATIONS USING THE BOOTSTRAP.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
E. Halfon.
Ecological Modelling ECMODT, Vol. 46, No. 3/ 4, p 213-219, August 1989. 1 tab, 17 ref.

Descriptors: *Water pollution effects, *Toxicity, *Model studies, *Computer programs, *Monte Carlo method, *Error analysis, *Statistical methods, *Bootstrap method, Model testing.

A recently developed statistical method, the bootstrap, was used to compare data and model simulations for an ecotoxicological model. As a test case, the validity of the relation, hypothesized by Neely, between the water solubility of an organic chemical and the ratio of the acute lethal concentration to fish (LC50), at two different exposure times was analyzed. To perform the bootstrap test, each of 24 data points was sampled with replacement 1000 times. The results of the analysis show that Neely's simulation model is likely (with an 88% probability) correct but it might have a systematic bias which makes the theoretical ratio slightly higher than the observed ratio. The bootstrap is an interesting statistical method which could be commonly used in model validation using a probabilistic approach. When computing resources are limited, the bootstrap validation might substitute error analysis by Monte Carlo methods, commonly used in ecological modelling, as the mathematical model is run only once. Coupled with systems methods, the bootstrap method could be used to establish the uncertainty of a hypothesis and to quantify a model validity in probabilistic terms. (Male-PTT)
W90-02660

MEIOBENTHIC NAIDID AND AEOLOSOMATID OLIGOCHAETES FROM THE PROFUNDAL ZONE, AND RELATIONS OF SPECIES TO EUTROPHICATION.
Jyvaeskylae Univ. (Finland). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-02663

POLLUTION AND TIDAL BENTHIC COMMUNITIES OF THE JAMES RIVER ESTUARY, VIRGINIA.
William and Mary Coll., Gloucester Point, VA. Inst. of Marine Science.
R. J. Diaz.
Hydrobiologia HYDRB8, Vol. 180, p 195-211, August 15, 1989. 7 fig, 3 tab, 60 ref.

Descriptors: *Benthos, *Estuaries, *Virginia, *James River, *Lotic environment, *Tide lands, *Water pollution effects, Saline-freshwater interfaces, Clams, Crustaceans, Oligochaetes, Aquatic insects, Species diversity, Sediments.

Distribution of benthic communities in the estuarine portion of the James River is controlled mainly by salinity. Pollution effects were localized and difficult to assess because of a rigorous physical environment. Mesohaline and oligohaline communities were very similar to those in other estuaries of the eastern United States. Macrobenthic densities were most severely depressed in tidal freshwater habitats near Richmond and Hopewell, where the major portion of the pollution load enters the river. Cluster analysis of species distributional patterns and ordination of pollution and physical parameters produced similar results, dividing the river into mesohaline, oligohaline, and upper and lower tidal freshwater zones. Further analysis of only the tidal freshwater portion indicated the distribution of benthic communities reflected the location and concentration of pollution sources along the river. Tidal freshwater communities were dominated by the Asiatic clam, Corbi-

cula fluminea, tubificid oligochaetes of the genus Limnodrilus and the chironomid insect larva Coelotanypus scapularis. The fauna of the freshwater zones was very eurytopic with respect to sediment type and has a great resemblance to the fauna of eutrophic lakes. The classical concept of a shaper increase in number of species occurring from oligohaline to freshwater zones is found misleading. This increase does not occur until free flowing (or lotic) freshwater areas of greater habitat diversity are reached. (Author's abstract)
W90-02664

AQUATIC TOXICITY TEST FOR ENCHYTRAEIDS.
Battelle-Inst. e.V., Frankfurt am Main (Germany, F.R.). Dept. of Toxicology and Pharmacology.
J. Roembke, and T. Knacker.
Hydrobiologia HYDRB8, Vol. 180, p 235-242, August 15, 1989. 2 fig, 6 tab, 21 ref.

Descriptors: *Toxicity, *Testing procedures, *Bioassay, *Water pollution effects, Chemical wastes, Aquatic environment, Daphnia.

A method for testing the toxicity of chemical substances uses enchytraeids in an aquatic environment. Up to eight different environmental chemicals were applied to various species, mainly of the genus Enchytraeus. Chemicals tested include benomyl, pentachlorophenol, parathion, 2,4,5-trichlorophenoxyacetic acid, chloroacetamide, cadmium chloride, tetropropyl-enebenzolesulphonate, potassium dichromate. The results were compared with those obtained for D. magna. Significant differences, however, between the LC 50 values of the various enchytraeid species and the LC sub 50 values for enchytraeids and daphnids were not observed. For E. cf. buchholzi the toxicological sensitivity of discrete ontogenetic stages was tested. The Aquatic Enchytraeid Test results were compared with those obtained from the Terrestrial Enchytraeid Test. It was found that in soil a chemical could be 600 times less toxic than in water, although the same species (E. albidus) was used in both environments. Even more pronounced were the discrepancies between the terrestrial and aquatic toxicities when the LC 50 values for earthworms and daphnids were compared. (Author's abstract)
W90-02666

ACUTE AND CHRONIC EFFECTS OF AN ANIONIC SURFACTANT ON SOME FRESHWATER TUBIFICID SPECIES.
Padua Univ. (Italy). Dept. of Biology.
S. Casellato, and P. Negrisolo.
Hydrobiologia HYDRB8, Vol. 180, p 243-252, August 15, 1989. 5 fig, 4 tab, 37 ref.

Descriptors: *Water pollution effects, *Tubificids, *Anions, *Surfactants, *Linear alkyl sulfonates, Bioassay, Toxicity, Sediments.

The results of research on acute and chronic effects of linear alkylbenzensulfonate (LAS) on two tubificid species are reported. Ninety-six hour LC50 assay values were estimated at 10 C for Limnodrilus hoffmeisteri and Branchiura sowerbyi exposed to different concentrations of LAS dissolved in water, both with and without sediment. The presence of sediments modified LAS toxicity and increased LC50 values: no observed effect concentration (NOEC) and lowest observed effect concentration (LOEC) resulted in values 2.5 times higher for Branchiura sowerbyi and 4-4.5 times for Limnodrilus hoffmeisteri, when the sediments were present. The chronic effects induced by a long exposure to LAS were evaluated for different stages of the biological cycle of Branchiura sowerbyi. Using concentrations between the NOEC and LOEC (0.5, 2.5, and 5 ppm), with control, it was observed that: (1) at 5 ppm the cocoons were laid precociously compared to controls, (2) in all treated series the number of cocoons was lower than in controls, (3) the mean number of oocytes per cocoon was lower for the worms submitted to LAS, compared to the control, (4) the period of embryonic development was similar for all concentrations used and for control, and (5) the number of degenerated cocoons was unchanged by the LAS treatment. (Author's abstract)

W90-02667

TOXICOLOGICAL PROPERTIES OF THIO- AND ALKYLPHENOLS CAUSING FLAVOR TAINTING IN FISH FROM THE UPPER WISCONSIN RIVER.
Radian Corp., Research Triangle Park, NC.
T. P. Heil, and R. C. Lindsay.
Journal of Environmental Science and Health JPFCD2, Vol. 24, No. 4, p 349-360, August 1989. 2 fig, 27 ref. National Sea Grant College Program, Grant NA84-D-0065, Project AS/A-8.

Descriptors: *Organoleptic properties, *Water pollution effects, *Bioassay, *Industrial wastewater, *Effluents, *Phenols, Aromatic compounds.

The toxicity of selected thiophenols and alkylphenols to the aquatic ecosystem was assessed using the Microtox assay. All samples were tested at 25 +/- 1 C. The alkylphenols and aromatic thiols tested were previously found in tainted Wisconsin River fish, including: 2-isopropylphenol, 3-isopropylphenol, 4-isopropylphenol, 2,4-diisopropylphenol, 2,5-diisopropylphenol, 2,6-diisopropylphenol, 3,5-diisopropylphenol, 2-methyl-5-isopropylphenol (carvacrol), 2-isopropyl-5-methylphenol (thymol), thiocresol and thiophenol. A photoluminescent assay which plotted % light lost/ % light remaining versus concentration of test substance was used to determine the concentration of compound responsible for a 50% decrease in light output after 5 minutes. Results show thymol and 3,5-diisopropylphenol to be the least toxic, and 2,4-diisopropylphenol and 4-isopropylphenol to be the most toxic. (Male-PTT)
W90-02671

SENSORY PROPERTIES OF THIO- AND ALKYL- PHENOLS CAUSING FLAVOR TAINTING IN FISH FROM THE UPPER WISCONSIN RIVER.
Radian Corp., Research Triangle Park, NC.
T. P. Heil, N. A. Lane, and R. C. Lindsay.
Journal of Environmental Science and Health JPFCD2, Vol. 24, No. 4, p 361-388, August 1989. 1 fig, 8 tab, 36 ref. National Sea Grant College Program, Grant NA84-D-0065, Project AS/A-8.

Descriptors: *Organoleptic properties, *Phenols, *Fish, Trout, Pike, Food chains.

A mixture of 10 parts per billion thiophenol, 1 ppb 3-isopropylphenol, 1 ppb 2,4-diisopropylphenol and 1 ppb carvacrol had nearly the same flavor quality as environmentally tainted northern pike when added to the flesh of untainted northern pike. Trout exposed to a mixture of alkylphenols and thiophenol (1-2 ppb each) in water did not become flavor tainted, but trout fed a formulated feed (2% body weight/day) containing 100 ppb added alkylphenols and thiophenol became strongly flavor tainted. Results suggest tainting via the food chain is important with these compounds. Tainting caused by thiophenol and isopropylphenols in tank-held trout was removed by holding the fish in clean water for five days. (Author's abstract)
W90-02672

PATCHINESS, COLLAPSE AND SUCCESSION OF A CYANOBACTERIAL BLOOM EVALUATED BY SYNOPTIC SAMPLING AND REMOTE SENSING.
Arizona State Univ., Tempe. Dept. of Zoology.
For primary bibliographic entry see Field 7B.
W90-02673

RESPONSE OF SOME COMMON FRESH WATER ALGAE TO DDT APPLICATIONS.
National Environmental Engineering Research Inst., Nagpur (India).
P. R. Chaudhari, I. Jayangouder, and K. P. Krishnamoorthi.
Proceedings of the Indian Academy of Sciences (Plant Sciences) PIPLDS, Vol. 99, No. 3, p 279-285, June 1989. 9 fig, 1 tab, 12 ref.

Descriptors: *Water pollution effects, *Toxicity, *Growth stages, *Chlorella, *Algae, *DDT, *Pes-

ticides, Organic pesticides, Chlorinated hydrocarbons, Scenedesmus, Spirulina.

Growth patterns of three common fresh water algae (Chlorella, Scenedesmus and Spirulina) were studied under the influence of the organochlorine pesticide DDT, under laboratory conditions. Scenedesmus was sensitive to DDT doses and growth was inhibited maximally up to 42% after 96 hours at 5 ppm concentration. This alga also shows phenotypic variations in its colony structure at 3 ppm concentration. Chlorella and Spirulina were highly tolerant and no growth inhibition was recorded at all doses of DDT (0.25-50 ppm). On the other hand, growth of these algae is promoted over that of control under the influence of DDT. There appear to be a connection between DDt toxicity and lipid content as previously reported. Scenedesmus had the highest lipid content (20%) while Chlorella was at 10% and Spirulina at 7% lipid content. (Male-PTT)
W90-02684

ENVIRONMENTAL EFFECTS ON SURVIVAL OF EGGS, LARVAE, AND JUVENILES OF STRIPED BASS IN THE CHOPTANK RIVER, MARYLAND.
Maryland Dept. of Natural Resources, Annapolis. Chesapeake Bay Research and Monitoring Div.
For primary bibliographic entry see Field 2H.
W90-02688

METALS IN FISH SCALES COLLECTED IN LAKE OPEONGO, CANADA, FROM 1939-1979.
Department of Fisheries and Oceans, Burlington (Ontario).
For primary bibliographic entry see Field 5A.
W90-02690

KILLING THE RHINE: IMMORAL, BUT IS IT ILLEGAL.
For primary bibliographic entry see Field 6E.
W90-02704

APPLICATION OF SHANNON-WIENER INDEX AS A MEASURE OF POLLUTION OF RIVER GANGA AT PATNA, BIHAR, INDIA.
Rajendra Agricultural Univ., Samastipur (India). Coll. of Fisheries.
For primary bibliographic entry see Field 5A.
W90-02705

METABOLIC RESISTANCE TO METHYL PARATHION TOXICITY IN A BIVALVE, LAMELLIDENS MARGINALIS.
Sri Venkateswara Univ., Tirupati (India). Dept. of Zoology.
C. Ravi Shankara, N. S. Ashok Babu, K. Indira, and W. Rajendra.
Current Science CUSCAM, Vol. 58, No. 13, p 766-769, July 5 1989. 1 tab, 18 ref.

Descriptors: *Toxicity, *Bioassay, *Mussels, *Mollusks, *Methyl parathion, Ammonia detoxification, Amino acids, Tolerance, Metabolism, Catalase, Xanthine oxidase, Glutaminase, Stress, Enzymes.

The biochemical and physiological responses to methyl parathion (MP) toxicity with reference to ammonia detoxification was evaluated in the tissues of the bivalve Lamellidens marginalis to assess the tissue-specific metabolic compensatory mechanisms that aid survival chances of mussels. Based on dose-mortality and tolerance data, a pesticide level of 15 ppm (sub-lethal concentration) was selected. After the stipulated time (1, 2, 3, and 4 weeks) foot and mantle from both control and MP-exposed mussels were excised and chilled to 0 C. Total protein, free amino acids (FAAs), catalase, xanthine oxidase, and glutaminase were estimated. Methyl parathion triggered acid and alkaline protease activity of the tissues which is always associated with high FAA levels. The rise in tissue FAA levels during MP stress might be a compensatory mechanism by which these FAAs provide energy through transdeamination during stress to meet the high energy demand. The increase in catalase ac-

tivity in the tissues of MP-exposed mussels indicates possible elevation of amino acid oxidase activity and predominance of deamination resulting in more peroxide formation. Glutamine oxidation was found to increase in response to the energy demand in the tissues under stress conditions. The increased activity of xanthine oxidase in the tissues of MP-exposed mussels indicates increased synthesis of uric acid under toxic stress. (White-Reimer-PTT)
W90-02706

EJECTION OF DROPS FROM THE SEA AND THEIR ENRICHMENT WITH BACTERIA AND OTHER MATERIALS: A REVIEW.
State Univ. of New York at Albany. Atmospheric Sciences Research Center.
For primary bibliographic entry see Field 5B.
W90-02707

REASSESSMENT OF THE STATUS OF THE BENTHIC MACROFAUNA OF THE RARITAN ESTUARY.
National Marine Fisheries Service, Highlands, NJ. Sandy Hook Lab.
F. W. Steimle, and J. Caracciolo-Ward.
Estuaries ESTUDO, Vol. 12, No. 3, p 145-156, September 1989. 6 fig, 4 tab, 64 ref.

Descriptors: *Macroinvertebrates, *New Jersey, *Water pollution effects, *Benthic fauna, *Raritan Estuary, Surveys, Data interpretation, Species diversity.

The benthic macrofauna of the Raritan estuary, at the mouth of New York Harbor, has been reported to be severely impacted by pollution, with a significant change occurring between surveys in the late 1950's and the early 1970's. This assessment is reviewed using five-fold more macrofaunal data (including biomass), not reported or used before, from a 1973-1974 survey. The new benthic data presented question the significance of all benthic community structural differences between the 1957-1960 and 1973-1974 studies. This reassessment suggests benthic community structure is not as degraded as previously reported and is, in many ways, similar to other relatively unpolluted middle Atlantic estuaries. If this suggestion is true, this may offer incentives to support necessary research to conserve, and in certain areas restore, rehabilitate, or enhance, its productivity. (Author's abstract)
W90-02710

ZOOPLANKTON DISTRIBUTION IN THREE ESTUARINE BAYOUS WITH DIFFERENT TYPES OF ANTHROPOGENIC INFLUENCE.
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
M. Vecchione.
Estuaries ESTUDO, Vol. 12, No. 3, p 169-179, September 1989. 11 fig, 2 tab, 43 ref. DOE Grant No. DE-FG01-83EP31111.

Descriptors: *Louisiana, *Zooplankton, *Water pollution effects, *Bayous, *Estuaries, Calcasieu Estuary, Municipal wastes, Industrial wastes, Farm wastes, Comparison studies, Species distribution.

Zooplankton was sampled in three tributaries of the Calcasieu Estuary: one flowing through an area of petrochemical industries, one through a municipal area, and one through an agricultural area. Synoptic comparisons among the bayous were made on eight trips over a two-year period. Additionally, each bayou was sampled intensively for small-scale distribution on four occasions. Numbers of all zooplankton taxa were consistently higher in the agricultural bayou than in either of the other bayous. Patterns of small-scale spatial variability also differed among the bayous The agricultural bayou appeared to be a relatively healthy estuarine tributary. The municipal bayou was probably subjected to chronic environmental stress that is very severe in the vicinity of the municipal sewage and storm-drain outfalls. Evidence indicated that the industrial bayou suffered from frequent, but not continuous, episodes of environmental stress through out its length. (Author's abstract)

W90-02712

AMPHIPOD PREDATION BY THE INFAUNAL POLYCHAETE, NEPHTYS INCISA.
Science Applications International Corp., Narragansett, RI.
M. S. Redmond, and K. J. Scott.
Estuaries ESTUDO, Vol. 12, No. 3, p 205-207, September 1989. 2 tab, 19 ref. EPA Contract No. 68-03-3236.

Descriptors: *Amphipods, *Toxicity, *Predation, *Polychaetes, Sediments, Gut contents, Nephtys incisa, Ampelisca, New England.

The results of one toxicity test and two subsequent experiments with the tubicolous amphipod Ampelisca abdita that examined Nephtys incisa predation on A. abdita are presented. Survival of A. abdita in a sediment toxicity test was negatively correlated with the presence of indigenous N. incisa. The gut contents of N. incisa held in uncontaminated sediment included identifiable portions of the amphipods A. abdita and Microdeutopus gryllotalpa. Although most nephtyid polychaete worms are active predators, Nephtys incisa has been considered a nonselective deposit-feeder. It was concluded that N. incisa will prey upon amphipods under laboratory conditions. This predation may be a factor in the exclusion of surface-dwelling amphipods from the Nephtys-Nucula community common in southern New England. (Author's abstract)
W90-02715

MODELING FATE AND TRANSPORT OF NUTRIENTS IN THE JAMES ESTUARY.
Virginia Univ., Charlottesville. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-02721

RESPONSES OF THE ACIDOPHILIC ALGA EUGLENA MUTABILIS (EUGLENOPHYCEAE) TO CARBON ENRICHMENT AT PH 3.
Toronto Univ. (Ontario). Dept. of Botany.
M. M. Olaveson, and P. M. Stokes.
Journal of Phycology JPYLAJ, Vol. 25, No. 3, p 529-539, September 1989. 5 fig, 4 tab, 47 ref.

Descriptors: *Acid streams, *Acid mine drainage, *Euglena, *Carbon, Hydrogen ion concentration, Growth, Photoauxitrophs, Acidophilic algae, Organic carbon, Carbon dioxide, Culturing techniques.

A defined medium (MAM) simulating acid mine drainage waters was developed which supported reproducible growth rates of three axenic strains of Euglena mutabilis Schmitz. Growth responses to various pHs and carbon sources were examined under defined culture conditions. A lab strain and two field isolates, tested over pH range 1.5-9.0, grew best under acidic conditions (pH <5.5) with highest growth rates at pH 3-4. Photoauxotrophic growth rates of all strains at pH 3 were improved significantly over unstirred batch controls by bubbling with air and even more by enrichment with 5% CO2 in air. These results confirmed inorganic carbon limitation in batch culture. Organic carbon substrates were tested as possible carbon supplements in batch culture at pH 3. None of the strains survived in the dark on any of the twenty organic sources added. In the light, the lab strain exhibited some photoheterotrophic growth potential on glucose, sucrose, ethanol, and amino acids, but growth was inhibited by acetate. Field strains showed little or no growth improvement with any organic substrate addition. Under simultaneous enrichment with acetate and 5% CO2, acetate continued to be inhibitory. Simultaneous enrichment with glucose and 5% CO2 gave higher yields of the lab strain than with CO2 alone but did not enhance growth of the field strain. It was concluded that E. mutabilis is an acidophilic photoauxotroph which appears to use organic carbon supplements for growth even under conditions of carbon limitation. (Author's abstract)
W90-02728

CLIMATE AND WATER RESOURCES.
Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR).
For primary bibliographic entry see Field 2A.
W90-02759

DEVELOPMENT OF A SOLID MEDIUM FOR GROWTH AND ISOLATION OF AXENIC MICROCYSTIS STRAINS (CYANOBACTERIA).
Ibaraki Univ., Ami (Japan). Dept. of Agricultural Chemistry.
For primary bibliographic entry see Field 7B.
W90-02788

WATERBORNE OUTBREAK OF CAMPYLOBACTER ENTERITIS AFTER OUTDOORS INFANTRY DRILL IN UTTI, FINLAND.
Valtion Elainlaaketieteellinen Laitos, Helsinki (Finland).
M. Aho, M. Kurki, H. Rautelin, and T. U. Kosunen.
Epidemiology and Infection EPINEU, Vol. 103, No. 1, p 133-141, Aug 1989. 3 fig, 2 tab, 28 ref.

Descriptors: *Pathogenic bacteria, *Contamination, *Campylobacter, Enteritis, Water pollution, Drinking water, Temperature, Finland.

Diarrhea, abdominal pain, malaise and fever affected 75 of the 88 conscript soldiers in Utti, Finland after an outdoors infantry drill. Campylobacter jejuni, heat-stable serotype 3/43/59, was isolated from 37 out of 63 men investigated. A clear serological response was evident in the risk group and negligible in the control group. The entire population at risk was interviewed. The outbreak was associated with the consumption of untreated surface water. C. jejuni, heat-stable serotype 3/43/59, was isolated on two occasions from the water source. In vitro studies have demonstrated that Campylobacter sp. remain viable for months in surface water at 4 C, and appear to survive best in water obtained from high mountain streams. In the outbreak studied, either the Campylobacter sp. survived in the cold water of the stream for 2 weeks, or there was a continuous source of the organisms upstream. (Authors's abstract)
W90-02815

MASS MORTALITY OF SALAMANDERS (AMBYSTOMA TIGRINUM) BY BACTERIA (ACINETOBACTER) IN AN OLIGOTROPHIC SEEPAGE MOUNTAIN LAKE.
Aspen Antibodies, Inc., McCammon, ID.
K. M. Worthylake, and P. Hovingh.
Great Basin Naturalist GRBNAR, Vol. 49, No. 3, p 364-372, 1989. 5 fig, 1 tab, 20 ref.

Descriptors: *Water pollution effects, *Grazing, *Amphibians, *Salamanders, *Utah, *Pathogenic bacteria, *Mountain lakes, Ambystoma, Acinetobacter, Mortality, Nitrogen, Water level.

Of the 13 lakes in the central Wasatch Mountains, Utah with tiger salamander (Ambystoma tigrinum) populations, salamander mass mortalities occurred in four seepage lakes that experienced extensive lowering of the water levels during the summer. The largest of these lakes, the oligotrophic Desolation Lake, was studied to determine the cause of the mortality phenomenon. The recurrent annual mass mortality involved both breeding adults and young-of-the-year. Rate kinetics suggest that mortality rate doubles with a fivefold increase in the number of aquatic young salamanders. The proximate cause of the mass mortality was identified as a bacterium, Acinetobacter sp. Desolation Lake and a seepage lake that did not experience the mass mortality were studied for the presence of Acinetobacter. Both lakes experienced two bacteria cycles: the first in early summer involved gram-positive bacteria, and the second in late summer involved gram-negative bacteria (mostly coliform bacteria and Acinetobacter). The mass mortalities were associated with the late-summer gram-negative bacterial bloom, and Acinetobacter was found in large numbers in Desolation Lake. Algae, as well as other photosynthetic plants, were not present in large numbers. Since these lakes are

growth-limited with respect to nitrogen and not with respect to phosphate, and since Desolation Lake had extensive lowering of the lake level during the summer, the biological cycle of the lake is proposed to be due to atmospheric and sheep-produced nitrogen products within the watershed. In this unstable lake system, bacteria are primarily responsible for incorporation of nitrogen in the food chain. The timing of the cyclical events depends on total winter precipitation. (Author's abstract)
W90-02817

SUPPRESSION OF ANTIBODY-PRODUCING CELLS IN RAINBOW TROUT SPLEEN SECTIONS EXPOSED TO COPPER IN VITRO.

National Fish Health Research Lab., Kearneys-ville, WV.
D. P. Anderson, O. W. Dixon, J. E. Bodammer, and E. F. Lizzio.
Journal of Aquatic Animal Health, Vol. 1, No. 1, p 57-61, March 1989. 1 fig, 14 ref.

Descriptors: *Water pollution effects, *Copper, *Fish, *Trout, *Toxicity, *Laboratory methods, Immunosuppression, Culturing techniques.

Suppression of the immune system of fishes may result from the action of pollutants in the environment on critical physiological pathways. Immunosuppression was demonstrated in sections of rainbow trout Oncorhynchus mykiss spleens immunized in vitro and exposed in culture to different concentrations of copper chloride. The sections were immunized with dinitrophenyl-Ficoll and cultured in Eagle's minimum essential medium with 2% fetal calf serum; half of the medium was withdrawn and replaced every other day. The passive hemolytic plaque assay was used to determine the number of antibody-producing cells 10 days after injection. In the sections cultured with the high copper concentration (100 micrograms/ml), all cells died; at copper concentrations of 0.1-10 micrograms/ml, leukocytes remained viable, but fewer antibody-producing cell were present than in organ sections cultured in medium without copper. This in vitro method reduces the number of animals needed and the length of time required to determine toxicity and immunosuppression, and it provides information on the effects of certain environmental pollutants on fish. (Ence-PTT)
W90-02827

INFLUENCE OF TRIBUTYLTIN ON IN VITRO ACTIVATION OF OYSTER TOADFISH MACROPHAGES.

Virginia Inst. of Marine Science, Gloucester Point.
C. D. Rice, and B. A. Weeks.
Journal of Aquatic Animal Health, Vol. 1, No. 1, p 62-68, March 1989. 5 fig, 36 ref.

Descriptors: *Pesticides, *Antifoulants, *Laboratory methods, *Toxicity, *Organotin compounds, *Water pollution effects, *Organic compounds, *Fish, Biological membranes, Fish physiology.

Selected species of fish exposed to toxic pollutants exhibit greatly reduced macrophage phagocytic, chemotactic, and chemiluminescent responses. Therefore, these fish may be more susceptible to infectious disease. The toxicity of the marine antifouling agent tributyltin (TBT) has been linked to cytological damage. The effect of TBT on the chemiluminescent response of peritoneal macrophages from the oyster toadfish Opsanus tau was studied using the pharmacological inducers phorbol myristate acetate (PMA) and calcium ionophore (A23187). The PMA-stimulated chemiluminescent response was increased by exposure to 50 micrograms TBT/L but was depressed to baseline values by 500 micrograms/L. With A23187-stimulated chemiluminescence, the response was increased by exposure to 5 and 50 micrograms TBT/L and was depressed by 500 micrograms TBT/L. The chemiluminescent response stimulated by synergistic doses of PMA and A23187 was also increased by exposure to 50 micrograms TBT/L and depressed by 500 micrograms/L. Chemiluminescence, enhanced by PMA and A23187 after TBT exposure, returned to baseline values after extracellular calcium was removed. In the

absence of PMA or A23187 stimulation, 50 micrograms TBT/L stimulated a significant chemiluminescent response that also was inhibited by chelation of extracellular calcium. Uptake of calcium-45 was greatly increased in the presence of 50 micrograms TBT/L but was depressed at 500 micrograms/L. The results suggest that, at certain concentrations, TBT stimulates a calcium influx and a resultant enhancement of the formation of reactive oxygen intermediates and the chemiluminescent response. It is postulated that, in stimulated macrophages, high levels of TBT lead to membrane dysfunction, which is followed by inhibition of calcuim flux and depression of chemiluminescence. (Ence-PTT)
W90-02828

RELATION OF HEPATIC MICROSOMAL MONOOXYGENASE ACTIVITY TO TISSUE PCBS IN RAINBOW TROUT (SALMO GAIRDNERI) INJECTED WITH (C14)PCBS.

Medical Coll. of Wisconsin, Inc., Milwaukee. Dept. of Pharmacology and Toxicology.
M. J. Melancon, K. A. Turnquist, and J. J. Lech.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 9, p 777-782, 1989. 5 fig, 1 tab, 21 ref. EPA Grant R810610; NIEHS Aquatic Biomedical Grant ES01985; and NIEHS Grant ES01080.

Descriptors: *Water pollution effects, *Trout, *Liver, *Enzymes, *Polychlorinated biphenyls, Organic compounds, Fish, Carbon radioisotopes.

Fish are exposed to a number of chemicals in the environment that are capable of inducing hepatic microsomal monooxygenase activity. The relationship of tissue PCB levels to this activity was assessed by injecting individual trout with corn oil vehicle or with a (C14)PCB mixture in corn oil. At 3 to 70 d after injection, tissue (C14)PCB concentrations were determined by scintillation counting of solubilized tissue samples, and hepatic microsomes were prepared and assayed for ethoxyresorufin-O-deethylase and ethoxycoumarin-O-deethylase activities. At three days after injection only the highest doses of PCBs caused elevation of hepatic microsomal monooxygenase activity. At later times, muscle and liver concentrations of PCBs at or lower than 250 ng/g were associated with hepatic microsomal monooxygenase activity at or near control levels. Elevated hepatic microsomal monooxygenase activity was associated with muscle and liver PCB concentrations 300 ng/g or higher, but not all fish with tissue PCBs above this concentration had elevated hepatic microsomal monooxygenase activity. (Author's abstract)
W90-02840

QSAR INVESTIGATION OF BENZENE TOXICITY TO FATHEAD MINNOW USING MOLECULAR CONNECTIVITY.

Eastern Nazarene Coll., Quincy, MA. Dept. of Chemistry.
L. H. Hall, E. L. Maynard, and L. B. Kier.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 9, p 783-788, 1989. 3 tab, 19 ref.

Descriptors: *Benzenes, *Toxicity, *Molecular structure, *Structure-activity relationships, *Fathead minnows, Mathematical models, Fish, Organic compounds, Water pollution effects.

The topological methods of molecular connectivity and kappa shape analysis have been applied to a set of 65 substituted benzenes and their toxicities to fathead minnow Pimephales promelas. The three variables, (1) the molecular connectivity index of the first order, (2) kappa modified using the ratio of covalent radii, and (3) a valence chi-index encoding atom type and electronic information, along with an ortho/para-dinitro indicator variable yield a quantitative structure/activity relationship (QSAR) equation with r=0.940, s=0.26 and F=1114. This equation is then used to estimate toxicities for 22 compounds not in the original data set. Twelve of the predicted compounds contain substituents in the original data set but 10 contain substituents new to the data, including fluoro-, cyano-, and acyl-. (Author's abstract)

W90-02841

BIOASSAY OF ACUTE TOXICITY OF HERBICIDE MIXTURE DALAPON/WEEDAZOL 4L ON ESTUARINE FAUNA.

Cawthron Inst., Nelson (New Zealand). Aquatic Resources Group.
P. A. Gillespie.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 9, p 809-815, 1989. 5 tab, 7 ref.

Descriptors: *Lethal limit, *Toxicity, *Herbicides, *Dalapon, *Ammonium compounds, *Estuarine environment, *Water pollution effects, Fauna, Organic compounds, Bioassay.

In recent years there has been increasing concern for the potential problem of the contamination of estuarine environments with agricultural chemicals. The acute toxicities of dilutions of a herbicide spray formulation suggested for use in salt-marsh environments to eradicate Spartina sp. have been estimated for six estuarine animal species using a dilution bioassay and direct spraying. Responses of the test species ranged from highly sensitive for the whitebait (Galaxias maculatus) (2-h LC50 of 0.45% corresponding to active ingredient concentrations of 36, 26 and 6 mg/L for dalapon, amitrole and NH4CNS, respectively) to extremely resistant for the mud crab (Helice crassa) (no mortality during a 4-h exposure after direct spraying with the full-strength mixture). Intermediate levels of toxicity were observed for the cockle (Chione stutchburyi), the mud snails (Amphibola crenata and Potamopyrgus estuarinus) and the estuarine prawn (Palaemon affinis). The results suggest that acute (lethal) effects on estuarine fauna would in most cases be minimal during actual spraying except where animals or shallow-pooled areas covering animals are sprayed directly. (Author's abstract)
W90-02843

OCTANOL/WATER PARTITION COEFFICIENTS AND BIOCONCENTRATION FACTORS OF CHLORONITROBENZENES IN RAINBOW TROUT (SALMO GAIRDNERI).

Bayfield Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W90-02844

IMPACT OF AN EPISODIC EVENT ON THE TOXICITY EVALUATION OF A TREATED MUNICIPAL EFFLUENT.

Procter and Gamble Co., Cincinnati, OH. Environmental Safety Dept.
For primary bibliographic entry see Field 5E.
W90-02845

WASTEWATER TREATMENT AND RECEIVING WATER BODY INTERACTIONS.

Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab.
L. A. Rossman.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-118426. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-88/206, October 1988. 46p, 19 fig, 3 tab, 22 ref.

Descriptors: *Wastewater disposal, *Waste load allocation, *Wastewater treatment, *Water quality, *Water pollution control, *Receiving water, *Ammonia, Mathematical studies, Chemical reactions, Economic aspects, Model studies.

The dynamic nature of the interactions between wastewater discharges and receiving water quality can complicate the analysis of pollution abatement programs; a numerical example of ammonia toxicity is used to illustrate this. It shows the role that correlated variables, chemical transformations, and water quality criteria play in determining water quality responses and their environmental significance. Methods of waste load allocation (the process of identifying discharge limits satisfying water quality criteria) that take these dynamic interactions into account include the steady-state response

approach, the dynamic respose approach, and the dynamic assimilative capacity approach. Also reviewed are pollution control strategies based on variable effluent limits. These can lower treatment costs by allowing discharge levels to change by time of year or with conditions in the receiving water. A waste load allocation method for seasonal discharge limits is introduced that maintains an equal risk of water quality criteria violation with nonseasonal limits. (Author's abstract)
W90-02921

CHEMICAL FATE OF BRASS DUST IN WATERS OF VARYING HARDNESS LEVELS.
Chemical Research and Development Center, Aberdeen Proving Ground, MD.
For primary bibliographic entry see Field 5B.
W90-02925

EVALUATION OF GRAPHITE FOR ENVIRONMENTAL TOXICITY USING THE STANDARD AQUATIC MICROCOSM.
Chemical Research and Development Center, Aberdeen Proving Ground, MD.
W. G. Landis, N. A. Chester, M. V. Haley, D. W. Johnson, and R. M. Tauber.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A199 722. Price codes: A03 in paper copy, A01 in microfiche. Report No. CRDEC-TR-88133, August 1988. 22p, 8 fig, 12 ref. Project No. 1C162622.

Descriptors: *Toxicology, *Model studies, *Graphite, *Water pollution effects, *Toxicity, Aquatic environment, Ammonia, Photosynthesis, Respiration, Eutrophication, Brass.

The impact of a graphite dust on an aquatic ecosystem model, the Standard Aquatic Microcosm (SAM), was investigated. Graphite dust (at 10 mg/L) produced effects that resembled eutrophication in that the species diversity decreased, ammonia increased, and a photosynthesis/respiration ratio of < 1 was observed at the highest concentration. Compared to brass dust, graphite has much less potential to adversely impact aquatic ecosystems. The results indicate that the SAM is capable of mimicking eutrophication at the community level. (Lantz-PTT)
W90-02926

EVALUATING IMPACTS OF POLLUTANTS FROM THE ATMOSPHERE.
Minnesota Univ., St. Paul. Dept. of Soil Science.
For primary bibliographic entry see Field 5B.
W90-02934

MEASUREMENT OF ZINC AMELIORATION OF CADMIUM TOXICITY IN CHLORELLA PYRENOIDOSA USING TURBIDOSTAT CULTURE.
Wisconsin Univ.-Milwaukee. Dept. of Biological Sciences.
W. N. Bennett, and A. S. Brooks.
Environment Toxicology and Chemistry ETOCDK, Vol. 8, No. 10, p 877-882, 1989. 3 fig, 1 tab, 33 ref.

Descriptors: *Synergistic effects, *Chlorella, *Water pollution effects, *Zinc, *Cadmium, *Toxicity, *Culturing techniques, Algae, Heavy metals, Turbidity.

The amelioration of cadmium toxicity by zinc was measured in terms of changes in the maximum specific growth rate (mu sub max) of a Chlorella pyrenoidosa population using turbidostat culture. In this continuous culture system, mu sub max is a dependent variable that responds directly to toxic effects. At a sublethal cadmium concentration (2.05 micromolar Cd) in the medium, the population mu sub max was in steady state at 70% of control values. When zinc was added to the medium to a concentration of 4.08 micromolar Zn, mu sub max increased immediately to a rate of 2.2% of control mu sub max per generation for seven generations, reaching steady state at 90% of the control. Additional increases in zinc did not elicit further increases in mu sub max. Full recovery of mu sub

max subsequently occurred after five generations in control medium. Mean cell size and percentage dry mass also changed during periods of toxicity and amelioration. Amelioration did not take place until the cellular Zn-to-Cd ratio approached 2. This could reflect interactions of the metals at a biochemical level. (Author's abstract)
W90-03206

EFFECTS OF FREEZING ON TOXICITY OF SEDIMENTS CONTAMINATED WITH DDT AND ENDRIN.
Corvallis Environmental Research Lab., OR.
G. S. Schuytema, A. V. Nebeker, W. L. Griffis, and C. E. Miller.
Environment Toxicology and Chemistry ETOCDK, Vol. 8, No. 10, p 883-891, 1989. 3 tab, 21 ref.

Descriptors: *Sample preservation, *Pollutant identification, *Synergistic effects, *Water pollution effects, *Sediment contamination, *DDT, *Endrin, *Sediments, *Toxicity, *Freezing, Cold resistance, Amphipods, Laboratory methods, Pesticides, Organic compounds, Organic carbon.

Little information is readily available on how the toxicity and availability of sediment contaminants can be influenced by sample storage prior to analysis. Freezing of sediments is generally not recommended but has been used as a preservation technique and is still employed by some researchers and many state and federal pollution control agencies. The objective of the present research was to evaluate the effect of freezing versus cold storage on the toxicity of contaminated sediments. Two freshwater sediments containing 3 and 11% total organic carbon (TOC) were spiked with DDT and endrin to compare the effects of cold (4 degrees C) and frozen (-20 degrees C) storage of the sediment on toxicity to the amphipod Hyalella azteca in 10-d tests. Toxicity of the DDT-spiked sediment was reduced when it was frozen for 14 d. LC50 values for cold-stored and frozen-stored sediments were 4.2 and 7.3 micrograms/g DDT (calculated on dry solids basis) at 3% sediment TOC and 11.1 and 23.2 micrograms/g DDT at 11% sediment TOC, respectively. Toxicity of the 3% TOC endrin-spiked sediment was reduced by freezing; it exhibited LC50s of 5.1 and 7.7 micrograms/g endrin, respectively, for cold and frozen storage. Toxicity of endrin in two tests in the 11% TOC sediment remained essentially unchanged by freezing. LC50s were 19.6 and 21.7 micrograms/g endrin for cold and frozen sediments in one test and 10.3 and 9.8 micrograms/g endrin in the second test. Decreased toxicity was assumed to be related to the release of soluble organic carbon from the sediments during freeing and thawing. Relative differences in toxicity between DDT and endrin for cold and frozen sediments appear to be related to the different adsorptions of the chemicals onto the released carbon. These results may suggest a possible increase in toxic breakdown products of DDT and the relative stability of endrin toxicity over time. It is concluded that data from studies using cold-stored and frozen-stored sediments may not be comparable. The freezing of sediments for testing or storage is not recommended. (Author's abstract)
W90-03207

CONSISTENT INHIBITION OF PERIPHERAL CHOLINESTERASES BY NEUROTOXINS FROM THE FRESHWATER CYANOBACTERIUM ANABAENA FLOS-AQUAE: STUDIES OF DUCKS, SWINE, MICE AND A STEER.
Illinois Univ., Urbana. Coll. of Veterinary Medicine.
W. O. Cook, V. R. Beasley, R. A. Lovell, A. M. Dahlem, and S. B. Hooser.
Environment Toxicology and Chemistry ETOCDK, Vol. 8, No. 10, p 915-922, 1989. 5 tab, 19 ref. Army Medical Research and Development Command Contract DAMD1785-C-5241.

Descriptors: *Anabaena, *Water pollution effects, *Enzymes, *Toxins, *Algal toxins, *Cyanophyta, *Animal pathology, Animal tissues, Tissue analysis, Chromatography, Eutrophication, Ducks, Hogs, Mice, Cattle.

Toxins from freshwater blue-green algae have been responsible for poisoning domestic and wild animals and have been implicated in human poisoning by municipal and recreational water supplies. The purpose of the present study was to examine two algal blooms associated with spontaneous cases of sudden death (one involving ducks and the other involving swine) for cholinesterase (ChE)-inhibiting toxins by means of :(a) analysis for antx-a(s) and insecticides; (b) ChE assays both in vitro and with tissues from field cases; (c) ChE assays and pathophysiology studies in experimentally dosed animals. Freshwater algal blooms associated with outbreaks of sudden death in ducks and swine were examined for ChE-inhibiting toxins as the possible cause of death. In both investigations, Anabaena flos-aquae was identified as the predominant alga in the bloom material. In both cases, assays on tissues from mice dosed intraperitoneally with algal extracts revealed inhibition of ChE in whole blood, plasma, diaphragm and lung, but not in brain. With algae from the field case involving ducks, toxicosis was experimentally reproduced by oral intubation in ducks and swine, but not in mice and a steer. However, the steer, as with other species, was susceptible to toxicosis induced by parenteral administration of an algal extract. Assays on tissues from affected animals revealed inhibition of ChE in whole blood, plasma, red blood cells, diaphragm, lung and pectoral muscle, but not in brain or retina. In vitro electric eel ChE assays with high-performance-liquid-chromatograph-purified extracts of the same alga revealed direct inhibition of acetylcholinesterase. Clinical signs in all animals were compatible with muscarinic and nicotinic cholinergic stimulation. Death of exposed animals is an apparent result of peripheral ChE inhibition. (Author's abstract)
W90-03209

TIME-TOXICITY RELATIONSHIPS IN FISH EXPOSED TO THE ORGANOCHLORINE PESTICIDE METHOXYCHLOR.
Alberta Environmental Centre, Vegreville.
T. A. Heming, A. Sharma, and Y. Kumar.
Environment Toxicology and Chemistry ETOCDK, Vol. 8, No. 10, p 923-932, 1989. 3 fig, 6 tab, 19 ref.

Descriptors: *Fish, *Toxicity, *Methoxychlor, *Pesticide kinetics, *Water pollution effects, *Chlorinated hydrocarbons, *Pesticides, Whitefish, Shiner, Sucker, Trout, Organic pesticides, Median tolerance limit.

Many pest control agents are applied in pulses of relatively brief duration and high concentration. The mechanisms and kinetics of toxicity associated with episodic exposures cannot be assumed to be the same as those associated with continuous exposures. The present study developed time-toxicity relationships for methoxychlor for five species and two stocks of fish (lake whitefish, Coregonus clupeaformis; spottail shiner, Notropis hudsonius; walleye, Stizostedion vitreum vitreum; white sucker, Catostomus commersoni; and two stocks of rainbow trout, Salmo gairdneri). Four different pulse regimes were tested, namely, a 2-h methoxychlor exposure followed by 94 h in fresh water, a 6-h exposure followed by 90 h in fresh water, a 24-h exposure followed by 72 h in fresh water, and a 96 h exposure. Time-toxicity relationships for methoxychlor varied interspecifically and intraspecifically. Intraspecies effects were probably size related; the 96-h median lethal concentration (LC50) for rainbow trout was 9.36 micrograms/L (95% C.L. 5.71, 15.3) for stock A fish (average size 1.2 g) and 31.2 micrograms/L (95% C.L. 24.7, 39.6) for stock B fish (average size 6.7 g). Methoxychlor exhibited a delayed toxic effect, the relative magnitude of which was a function of exposure duration and concentration, and fish species. Of the fish species examined, walleye was the most sensitive to short-term pulses (<24 h) of methoxychlor. Walleye had a relatively low 96-h LC50 (19.2 micrograms/L; 95% C.L. 9.00, 41.1), experienced the greatest delayed toxic effects and, in terms of median survival time (t sub m), was most sensitive to changes in methoxychlor concentration. Rainbow trout appeared to be the species most sensitive to chronic methoxychlor exposure; its asymptotic LC50

(stock A 4.05 +/-2.84 micrograms/L, stock B 5.14 +/-3.14 micrograms/L) was significantly lower than those of other species. White sucker was the species least sensitive to acute exposure. White suckers experienced no delayed toxic effects and had the highest 96-h (114 micrograms/L; 95% C.L. 87.7, 150) and asymptotic LC50 (205 +/-85 micrograms/L) values. (Author's abstract)
W90-03210

CHRONIC EFFECTS OF THE PHOTOEN-HANCED TOXICITY OF ANTHRACENE ON DAPHNIA MAGNA REPRODUCTION.
Michigan State Univ., East Lansing. Pesticide Research Center.
L. L. Holst, and J. P. Giesy.
Environment Toxicology and Chemistry ETOCDK, Vol. 8, No. 10, p 933-942, 1989. 5 fig, 5 tab, 27 ref. National Sea Grant College Program Grant MA-86AA-D-SG-043.

Descriptors: *Reproduction, *Anthracene, *Synergistic effects, *Daphnia, *Aromatic compounds, *Water pollution effects, *Toxicity, *Ultraviolet radiation, Embryonic growth stage, Aquatic animals, Organic compounds, Petroleum products, Polycyclic aromatic hydrocarbons.

Polycyclic aromatic hydrocarbons (PAHs) are a class of organic compounds consisting of two or more fused benzene rings with occasional inclusions of heteroatoms or cyclopentene rings. PAHs are of environmental concern not only because large quantities of them are released into the environment, but also because many PAHs are carcinogenic to mammals and phototoxic to aquatic organisms. Anthracene is a linear, three-ring PAH found in both oil and coal. In this study the chronic effects of exposure to anthracene and ultraviolet radiation (UVR) on Daphnia magna reproduction were investigated. D. Magna were exposed to anthracene in the presence or absence of ecologically relevant intensities of UVR for 21 d. Exposure to 8.2 micrograms/L anthracene in the absence of UVR significantly reduced the number of neonates produced by 13.8%; however, exposure the UVR in the absence of anthracene had no significant effect on the fecundity of D. magna. Concurrent exposure of D. magna to UVR and anthracene resulted in further reduced survival and fecundity. Exposure of D. magna to 7.2 micrograms/L anthracene and 117 microwatts/square cm UV-A radiation resulted in 70% mortality or a 69% decrease in production of neonates by D. magna that survived. The reduction in fecundity was proportional to both anthracene concentration and UVR intensity. Equations were developed that predict the relative percent reduction in production of neonates due to the photoenhanced toxicity of anthracene given a particular anthracene concentration and UVR intensity. This study has demonstrated that anthracene in the presence of UVR decreases the survival and fecundity of D. magna at concentrations well under aqueous solubility limits. (Author's abstract)
W90-03211

TOXIC EFFECTS OF BORON ON MALLARD REPRODUCTION.
Patuxent Wildlife Research Center, Laurel, MD.
G. J. Smith, and V. P. Anders.
Environment Toxicology and Chemistry ETOCDK, Vol. 8, No. 10, p 943-950, 1989. 6 tab, 25 ref. Bureau of Reclamation/Fish and Wildlife Service Intragency Agreement 6-AA-20-04170.

Descriptors: *Toxicity, *Reproduction, *Boron, *Ducks, *Eggs, *Food chains, *Agricultural runoff, Embryonic growth stage, Waterfowl, Water pollution effects, Irrigation effects.

Boron, a naturally occurring trace element, is widespread in nature and the natural boron content of soils is usually between 10 and 300 ppm. It is generally considered environmentally innocuous; however, it was documented to severely impair mallard reproduction. Boron is leached from irrigated agricultural soils and transported in drainage water that contaminates wetlands. Until now, only the selenium accumulated in aquatic food chains has been documented to pose a toxic hazard to

wildlife in drainage water wetlands. Adult mallard (Anas platyrhynchos) ducks were fed diets supplemented with 0, 30, 300 or 1,000 ppm boron (fresh weight; diets contained about 10% moisture). The hatching success of fertile eggs was significantly reduced by 1,000 ppm boron, less than one-third of the highest boron concentrations found in plants in California's San Joaquin Valley. Hatching weights, duckling survival and duckling weight gain were also reduced by 1,000 ppm boron. Boron concentrations in mallard egg, liver and brain tissues were dose-related. Boron did not affect adult survival or egg fertility. The hatching success of fertile eggs for mallards fed diets with 30 or 300 ppm boron did not differ from that of the control group. Management of drainage water-contaminated environments must now also consider the adverse effects of boron, as well as the possible interactions of drainage water contaminants. (Author's abstract)
W90-03212

HUMAN SERUM DDT LEVELS RELATED TO CONSUMPTION OF FISH FROM THE COASTAL WATERS OF LOS ANGELES.
Southern California Coastal Water Research Project, Long Beach.
R. Gossett, G. Wikholm, J. Ljubenkov, and D. Steinman.
Environment Toxicology and Chemistry ETOCDK, Vol. 8, No. 10, p 951-955, 1989. 4 tab, 8 ref.

Descriptors: *Human pathology, *DDT, *DDD, *DDE, *Polychlorinated biphenyls, *Fish, *Food chains, *Water pollution effects, *Los Angeles, *Coastal waters, Population exposure, Metabolites, Organic compounds.

Fish from Los Angeles County coastal waters contain high concentrations of the banned pesticide DDT, it metabolites DDE and DDD, and polychlorinated biphenyls (PCBs). The most popular sportfish caught from piers in southern California (comprising 30% of the catch), white croaker (Genyonemus lineatus), contains total DDT levels above the Federal Drug Administration guideline (5 mg/kg wet weight) in edible tissue at 7.6 mg/kg wet weight total DDT. We quantified blood serum levels of DDTs and PCBs in 16 subjects who consumed locally caught sportfish at least three times a week for 3 years and compared them with those in nine control subjects who consumed little or no local fish. No subjects or controls had other known significant exposures to DDT and its metabolites. The consumers of locally caught sportfish had significantly higher serum levels of total DDT (mean 35 ng/ml) than did nonconsumers (mean 7 ng/ml). Within the consumer groups, serum levels of 4,4-prime-DDE and fish consumption history were significantly correlated. The number of sportfish meals consumed also was correlated with DDE blood serum concentrations. This was not the case for total PCB, probably because of the multiple sources of this contaminant. (Author's abstract)
W90-03213

IMPACT OF GROUNDWATER CONTAMINATION OF PUBLIC WATER SUPPLIES.
Montgomery (James M.), Inc., Gainesville, FL.
For primary bibliographic entry see Field 5F.
W90-03217

MORTALITY ASSOCIATED WITH PHYTOPLANKTON BLOOMS AMONG FARMED ATLANTIC SALMON, SALMO SALAR L., IN SCOTLAND.
Marine Lab., Aberdeen (Scotland).
D. W. Bruno, G. Dear, and D. D. Seaton.
Aquaculture AQCLAL, Vol. 78, No. 3-4, p 217-222, June 1989. 1 fig, 1 tab, 6 ref.

Descriptors: *Fish farming, *Salmon, *Scotland, *Eutrophication, *Fishkill, *Phytoplankton, *Water pollution effects, *Algal growth, Fisheries, Diatoms, Mortality, Economic aspects.

Rapid and significant losses occurred among farmed Atlantic salmon, Salmo salar L., held in

cages in Loch Torridon, and on the west coast of the Shetland Isles, Scotland between June and July 1988. Fish deaths were attributed to contact with phytoplankton blooms. In both Loch Torridon and the Shetland incident there were very high numbers of diatom species, these and the additional presence of a silicoflagellate in the Shetland Isles case were considered to have caused severe irritation of the gills leading to necrosis, extensive sloughing of the gill lamellae and in consequence respiratory failure. The market value of the fish lost, had they progressed to harvesting, has been estimated at several million pounds. (Author's abstract)
W90-03238

PHOTOSYNTHESIS OF ALGAL CULTURES AND PHYTOPLANKTON FOLLOWING AN ACID PH SHOCK.
Toronto Univ. (Ontario). Div. of Life Sciences.
C. Nalewajko, and M. A. O'Mahony.
Journal of Phycology JPYLAJ, Vol. 25, No. 2, p 319-325, June 1989. 4 fig, 4 tab, 25 ref. Associate Committee on Scientific Criteria for Environmental Quality Grant 05082-00267.

Descriptors: *Acid rain effects, *Lake acidification, *Algae, *Hydrogen ion concentration, *Lakes, *Phytoplankton, *Photosynthesis, Acidic water, Carbon, Pyrrophyta, Acid tolerance.

In acidifying lakes, pH decreases abruptly in response to acid precipitation events. The hypothesis was tested that, in comparison to a circumneutral lake, phytoplankton photosynthesis in an acidifying lake is less sensitive to a rapid decrease in ph (acid pH shock). Phytoplankton in Plastic Lake, which is undergoing acidification, was characterized by a predominance of Pyrophyta, and phytoplankton photosynthesis decreased to a lesser extent in response to an acid pH shock than the photosynthesis of populations from St. Nora Lake, a circumneutral lake located nearby, in which Pyrrophyta were not abundant. Rates of phytoplankton photosynthesis in acid pH shock experiments were significantly correlated with hydrogen ion but not with dissolved inorganic carbon concentrations. Depression of photosynthesis following an acid pH shock occurred in xenic culture of Chlorella pyrenoidosa Chick but was not observed in axenic cultures of the acidophilic alga Chlorella saccharophila (Krug.) Nadson or in three species isolated form Plastic Lake. However, the three isolates were not acidophilic during growth. It was concluded that phytoplankton in acidifying lakes consists predominantly of species which are tolerant to acid pH for short periods (hours) but cannot grow at these pHs. (Author's abstract)
W90-03259

OXYGEN-INDUCED CHANGES IN MORPHOLOGY OF AGGREGATES OF APHANIZOMENON FLOS-AQUAE (CYANOPHYCEAE): IMPLICATIONS FOR NITROGEN FIXATION POTENTIALS.
Michigan State Univ., Hickory Corners. W.K. Kellogg Biological Station.
R. G. Carlton, and H. W. Paerl.
Journal of Phycology JPYLAJ, Vol. 25, No. 2, p 326-333, June 1989. 11 fig, 2 tab, 26 ref. NSF Subventions BSR8705342, BSR8614951, and OCE8500740.

Descriptors: *Limnology, *Phytoplankton, *Cyanophyta, *Biological pollution, *Nitrogen fixation, *Photosynthesis, *Nutrients, *Oxygen, Aggregates, Lakes, Light effects, Morphology.

Among dominant freshwater bloom-forming cyanobacteria, the genus Aphanizomenon is notorious because of its frequent proliferation as persistent, odoriferous, aesthetically-detracting, and, at times, toxic surface scums. In A. flos-aquae, these scums consist of bundle or flake shaped aggregates which can provide buoyancy control, protection against intense illumination, enhancement of phycosphere nutrient regeneration, and which may result from size-selective herbivory by zooplankton. The dimensions of aggregates can change quickly. In this study, after a period of darkness, illumination

caused aggregates to elongate approximately five-fold over a 10-15 min period. The metamorphosis was reversible upon cessation of illumination and through successive light-dark cycles. Manipulations of environmental oxygen concentration and photosystem II activity (via DCMU amendment), together with measurements made inside flakes with O2-sensitive microelectrodes, showed that the metamorphosis was a response to oxygen concentration and operated to enhance diffusive efflux of photosynthetically produced oxygen during illumination. During darkness oxygen concentration within contracted aggregates became severely depleted relative to the environment. It is proposed that metamorphic minimization of local oxygen concentration is an adaptation that enhances the ability of Aphanizomenon flos-aquae to fix atmospheric nitrogen via the oxygen-labile nitrogenase enzyme system. (Author's abstract)
W90-03260

EFFECTS OF SUSPENDED SEDIMENT, HYPOXIA, AND HYPEROXIA ON LARVAL MERCENARIA MERCENARIA (LINNAEUS, 1758).
Delaware Univ., Lewes. Coll. of Marine Studies.
K. M. Huntington, and D. C. Miller.
Journal of Shellfish Research JSHRDA, Vol. 8, No. 1, p 37-42, June 1989. 3 fig, 1 tab, 18 ref. NOAA Grant NA-86-AAD-SG-040.

Descriptors: *Oxygen depletion, *Supersaturation, *Eutrophication, *Coastal waters, *Larvae, *Suspended sediments, *Dissolved oxygen, *Clams, *Water pollution effects, Growth, Larval growth stage, Benthos, Bays.

Recruitment to benthic environments by Mercenaria mercenaria (L.) larvae may be influenced by suspended sediment loads and dissolved oxygen concentrations. The effect of these factors on survival and growth of one to four day-old hard clam veligers was tested in the laboratory. A tumbler maintained particles in suspension during 48-hr suspended sediment (0-2200 milligrams/liter), 24-hr hypoxic (1-6.5 milligrams/liter; 15-90% saturation at 22 C) and 24-hr hyperoxic (13.7 milligrams/liter, 180% saturation at 20 C) experiments. Larval survival was not affected by any of the treatments. Growth, however, (as indicated by changes in mean size over time) was negatively affected by 2200 milligrams/liter sediments and 13.6 milligrams/liter (180% saturation) dissolved oxygen concentration. Daily afternoon supersaturation, common in eutrophic systems, and infrequent episodes of very high loads of suspended sediments may thus negatively impact M. mercenaria growth during the larval stage. (Author's abstract)
W90-03261

EFFECT OF PESTICIDES ON THE GROWTH OF AQUATIC HYPHOMYCETES.
Mangalore Univ. (India). Dept. of Biosciences.
K. R. Chandrashekar, and K. M. Kaveriappa.
Toxicology Letters TOLED5, Vol. 48, No. 3, p 311-315, Sep. 1989. 1 tab, 14 ref.

Descriptors: *Water pollution effects, *Path of pollutants, *Pesticides, *Aquatic fungi, *Plant growth, Paraquat, Phenoxy acid pesticides, Herbicides, Agricultural runoff, Rivers, Aquatic life, Biological magnification, Biotransformation, Culturing techniques, India.

Most of the rivers in India's Western Ghat forests are lined by plantation crops or forest vegetation. The plantation crops (rubber, coffee and arecanut) are sprayed with pesticides to control pests and diseases. Due to heavy monsoon rains, pesticides leach and enter nearby streams and rivers. The aquatic hyphomycetes which normally colonize plant materials in such waters play an important role in the trophic structure of aquatic ecosystems. The most important factor in an aquatic ecosystem is the biological magnification of pesticides present in the water. The effect of two herbicides (paraquat and 2,4-dichlorophenoxybutyric acid) and two fungicides (mancozeb and captafol) was studied on the growth of Flagellospora penicillioides, Lunulospora curvula and Phalangispora constricta using the poisoned-food technique. The pesticides did not produce any inhibition of growth at con-

centrations up to 5 mg/L. The required concentration to bring about total inhibition of growth varied among the chemicals and the cultures. The herbicides produced a slight enhancement of culture growth at concentrations ranging from 1 to 25 mg/L. It seems that microbial activity is important in biochemical transformations of pesticides in aquatic ecosystems. In this context, the growth increment of fungi in the presence of low concentrations of pesticides as observed in the present study is significant. (Shidler-PTT)
W90-03264

FORAGING IN CENTRAL VALLEY AGRICULTURAL DRAINAGE AREAS.
California Univ., Davis. Dept. of Applied Behavioral Sciences.
For primary bibliographic entry see Field 6G.
W90-03323

CANCER INCIDENCE FOLLOWING EXPOSURE TO DRINKING WATER WITH ASBESTOS LEACHATE.
Illinois State Dept. of Public Health, Springfield. Div. of Epidemiologic Studies.
H. L. Howe, P. E. Wolfgang, W. S. Burnett, P. C. Nasca, and L. Youngblood.
Public Health Reports PHRPA6, Vol. 104, No. 3, p 251-256, May/June 1989. 3 tab, 22 ref.

Descriptors: *Water pollution effects, *Carcinogens, *Asbestos, *Leachates, *Drinking water, *New York, Human pathology, Epidemiology, Statistics.

The carcinogenic effects of asbestos exposure are associated with serious and fatal illness. Most studies have examined disease risk among persons occupationally exposed to air-borne asbestos fibers. Since occupational exposure to asbestos is related to increased risk of cancer of the gastrointestinal tract, long-term ingestion of the fibers may increase risk. In November 1985, the New York State Department of Health was alerted to extraordinary concentrations of asbestos leachate in the drinking water in the Town of Woodstock. Concentrations of 3.2 million fibers per liter (MFL) to 304.5 MFL were found, depending on location. An investigation of cancer incidence in the area was conducted for the period 1973-83 using the State Cancer Registry to compute standardized incidence ratios. No evidence was found of elevated cancer incidence at sites associated with asbestos exposure. A statistically non-significant excess of kidney cancer was seen among men, but not women. Colon cancer among men was significantly low, but incidence among women was similar to that expected. Lung cancer incidence was lower than expected for both sexes. Ovarian cancer rates were not different from expected rates. At sites not previously related to asbestos exposure, cancer of the oral cavity was significantly high, with most affected persons having a history of cigarette smoking. Surveillance of the community is continuing because of an insufficient latent period for some exposed groups. (Author's abstract)
W90-03341

HEAVY METAL ANALYSIS IN FISH-KILL CASES IN RIVERS IN GUIPUZCOA (SPAIN).
Universidad del Pais Vasco, San Sebastian (Spain). Lab. Contaminacion.
I. Legorburu, and L. Canton.
Toxicological and Environmental Chemistry TXECBP, Vol. 23, No. 1-4, p 161-167, 1989. 1 fig, 4 tab, 13 ref.

Descriptors: *Bioindicators, *Heavy metals, *Chemical analysis, *Fishkill, *Spain, *Pollutant identification, *Water pollution effects, Rivers, Industrial wastewater, Urola River, Aluminum, Copper, Cyanide, Atomic absorption spectroscopy, Water pollution.

One of the most relevant indicators of water quality changes we have is fish-kills. Nine fish-kills in Basque rivers were studied by gill tissue analysis: Samples were wet digested and the solution was analyzed by atomic absorption spectroscopy. A survey of metal levels in fishes from River Urola

made in 1986-87 provided enough data to calculate background values for fishes in the area. In three cases, the cause was linked to the effluents of an aluminum anodizing factory. Cyanide from an unknown source caused one kill and copper wastes were related with another. Three cases were attributed to natural reasons and one of the kills was of unknown origin. It was concluded that analysis of gills can be used to detect abnormal concentrations of metal in dead fishes, and, in some cases, point to the origin of their death. (Author's abstract)
W90-03352

MONITORING OF HARMFUL SUBSTANCES IN RUNNING WATER BY MEANS OF BEHAVIOR PARAMETERS IN CONTINUOUSLY SWIMMING FISH.
Universitaet des Saarlandes, Saarbruecken (Germany, F.R.). Zoologisches Inst.
For primary bibliographic entry see Field 5A.
W90-03353

CHANGE OF BEHAVIOR WITH ATRAZINE IN AN ELECTRIC FISH.
Stuttgart Univ. (Germany, F.R.). Biologisches Inst.
P. Kunze.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 22, No. 3, p 108-111, July 17, 1989. 3 fig, 11 ref. English summary.

Descriptors: *Pesticides, *Herbicides, *Water pollution effects, *Fish behavior, *Atrazine, *Toxicity, Triazine herbicides, Pollutants, Aquariums.

Weakly electric fish, Gnathonemus petersii, were exposed to atrazine concentrations in the aquarium water of 0.025 to 0.5 mg/L. All concentrations elicited significant changes of electric behavior which became apparent especially as a decrease of number of impulses at intervals shorter than 120 ms. This change of behavior starts at the latest 12-18 min after atrazine contamination and persists during the time of contamination. (Author's abstract)
W90-03354

FISH DISTRIBUTION IN RICHLAND CREEK, AN URBANIZING STREAM BASIN IN SOUTHWESTERN ILLINOIS.
Southern Illinois Univ. at Edwardsville. Dept. of Biological Sciences.
For primary bibliographic entry see Field 4C.
W90-03384

CADMIUM INDUCED MALFORMATION IN EYES OF AMBASSIS COMMERSONI CUVIER.
Central Electrochemical Research Inst., Karaikudi (India).
V. Pragatheeswaran, B. Loganathan, R. Natarajan, and V. K. Venugopalan.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 5, p 755-760, November 1989. 2 fig, 16 ref.

Descriptors: *Cadmium, *Toxicity, *Fish diseases, *Animal pathology, *Water pollution effects, *Bioassay, *Estuarine environment, Fish, Heavy metals, Morbidity, Eyes, India.

Pathological manifestations in fishes from the polluted environment reflect the deleterious effects of environmental damage to higher animals in the food chain including man. During earlier investigations on acute toxicity of cadmium on the estuarine fish Ambassis commersoni, the manifestations of creamy white eyes and protrusion of eyeballs, leading to death of the fish were observed. Groups of 15 adult A. commersoni, collected from the marine zone of the Vellar estuary (India), were exposed to 2, 3, or 4 ppm cadmium for up to 15 days. Loss of original color, protrusion of eyeballs and sloughing off of the structures of eyes were observed in 3 of 15 fishes at all exposure levels by 8 days of exposure. The eyes gradually enlarged and protruded as an exopothalmia, and the affected fish died within 10 days. No eye malformation were observed at 0.5 and 1 ppm exposure. Affected fish frequently hit

the walls of the tank and laid on the bottom most of the time. Normal swimming behavior was also altered. Glycogen content was found to be low in all cadmium-treated fishes. Liver size of affected fish was decreased, and nearly 95% of the liver glycogen and 76% of the muscle glycogen were exhausted in the affected fish just before death. (VerNooy-PTT)
W90-03427

TEMPERATURE PREFERENCE AS AN INDICATOR OF THE CHRONIC TOXICITY OF CUPRIC IONS TO MOZAMBIQUE TILAPIA.
Maryland Univ., Frostburg. Appalachian Environmental Lab.
T. J. Welch, J. R. Stauffer, and R. P. Morgan.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 5, p 761-768, November 1989. 2 fig, 24 ref.

Descriptors: *Water pollution effects, *Temperature effects, *Toxicity, *Bioindicators, *Tilapia, *Copper, *Fish behavior, Water temperature, Cations, Mortality, Bioassay.

Toxicological modification of specific behavioral patterns is often associated with the ability of a fish to survive environmental perturbations. Temperature is an easily quantifiable parameter influencing both the behavior and survival of fishes. The feasibility of using acute temperature preference tests to assess the chronic toxicity of low concentrations of free cupric ions to Mozambique tilapia, Oreochromis mossambicus (Peters), was evaluated. Groups of 15 juvenile tilapia were exposed to either 0 or 0.06 mg/L cupric ion for 8 days at 15, 25, and 35 C. Mortality varied with acclimation temperature and toxicant exposure. No mortalities occurred in the control groups, while all fish exposed to copper at 15 C died. Copper-exposed and control fish acclimated to 25 C preferred wider ranges of temperatures with considerable overlap between the two groups. However, only three copper-exposed fish preferred temperatures of 34 C or greater while control fish preferred temperatures greater than 34 C exclusively. Chronic exposure of tilapia to 0.06 mg cupric ion/L at three temperatures resulted in three different responses: total mortality (15 C), low mortality (25 C), and low mortality plus behavior modification (35 C). Acute temperature preference tests are sensitive indicators of chronic copper toxicity and may be used to detect changes in fish behavioral patterns caused by exposure to aquatic contaminants. Tests, however, should include several acclimation temperatures in order to thoroughly assess the toxicity of a contaminant. (VerNooy-PTT)
W90-03428

CHANGES INDUCED BY CADMIUM IN THE KIDNEY OF BLACK SEA BREAM, MYLIO MACROCEPHALUS (TELEOSTEI).
Chinese Univ. of Hong Kong, Shatin. Dept. of Biology.
V. E. C. Ooi, and F. K. Law.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 5, p 769-775, November 1989. 10 fig, 18 ref.

Descriptors: *Cadmium, *Animal pathology, *Toxicity, *Marine fisheries, *Water pollution effects, *Bream, *Heavy metals, Kidneys, Aquaculture, Morbidity, Bioassay.

Little is known about injurious effects of cadmium on marine fish. The time course of cadmium-induced renal toxicity and histopathological changes of the kidneys of the black sea bream, one of the most common maricultural fish species in Hong Kong was examined. Groups of 9 young black sea breams, Mylio macrocephalus (20 to 30 g body weight), were given one of the following treatments: a single intraperitoneal (ip) injection of cadmium chloride in 0.9% saline at a dosage of 7.5 mg/kg body weight; two ip injections of cadmium chloride at day 0 and 7; or three ip injections of cadmium chloride at day 0, 7, and 14. Nine control fish received similar ip injections of 10 mg saline/kg body wt. Three fish of each group were sacrificed 1, 2, or 3 weeks after the last injection. The extent of histological changes in the kidney was

related to the number of injections and exposure time. A single dose of 7.5 mg/kg produced severe acute renal damage. Microscopic findings of kidney injury included early deformation of brush border, atrophy of basal cytoplasm and nuclear pyknosis in the proximal tubules, and necrotic changes in renal corpuscles. The proximal tubules appeared to be more sensitive to cadmium exposure than the other segment of tubule and renal corpuscle. However, in the kidneys of fish treated with three doses of cadmium, even the distal tubules and collecting ducts were affected. After 3 or 4 weeks, the glomeruli of renal corpuscles were highly disorganized in an advanced stage of degeneration. (VerNooy-PTT)
W90-03429

ACUTE TOXICITY OF POTASSIUM PERMANGANATE TO MILKFISH FINGERLINGS, CHANOS CHANOS.
Southeast Asian Fisheries Development Center, Iloilo (Philippines). Aquaculture Dept.
E. R. Curz, and C. T. Tamse.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 5, p 785-788, November 1989. 1 fig, 1 tab, 17 ref. International Dev. Res. Center of Canada Project No. 3-P-81-0171.

Descriptors: *Water pollution effects, *Toxicity, *Milkfish, *Potassium compounds, *Bioassay, Mortality, Fish behavior, Potassium permanganate.

Potassium permanganate (KMnO4) is a strong oxidizing agent commonly used in aquatic systems to improve available oxygen, treat infectious diseases and parasites, detoxify fish poisons, and control algae. Milkfish fingerlings (Chanos chanos) weighing 3.0 to 5.0 g were starved 24 hr prior to and during acute exposure to KMnO4 in water at 27 C and with a pH of 8.4. Toxicity tests were carried out under static conditions in glass aquaria for 96 hr. Groups of ten fish were exposed to each concentration of KMnO4 (1.0, 1.25, 1.3, 1.35, 1.4, 1.45, 1.5 and 1.8 mg/L) or were in a control test. Fish behavior immediately after addition of KMnO4 was an avoidance response. Fish exhibited rapid opercular movements and increased swimming activity. Even after 96 hr, fish exposed to 1.0 and 1.25 mg/L KMnO4 could tolerate the chemical. However at 1.80 mg/L, all test fish were dead within 6 to 24 hr. The mean LC5, LC50 and LC95 values for 24 hr exposure were 1.5070, 1.4860, and 1.7257 mg/L, respectively. Similar lethal values for 96 hr exposure were 1.2317, 1.4757, and 1.6980 mg/L respectively. (VerNooy-PTT)
W90-03431

TOXICITY OF THE ORGANOPHOSPHATE INSECTICIDE FENTHION, ALONE AND WITH THERMAL FOG CARRIERS, TO AN ESTUARINE COPEPOD AND YOUNG FISH.
New England Univ., Biddeford, ME. Div. of Life Sciences.
C. Q. Thompson, and J. W. Tucker.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 5, p 789-796, November 1989. 1 fig, 1 tab, 11 ref.

Descriptors: *Toxicity, *Organophosphorus pesticides, *Copepods, *Fish eggs, *Water pollution effects, *Insecticides, *Fuel, Estuaries, Trout, Snook, Spot, Menhaden, Synergistic effects, Mortality, Bioassay.

Fenthion often is applied aerially as a thermal fog over land adjacent to coastal waters and marshes for control of adult mosquitoes. Fog formulations are a mixture of mostly fuel oil and a lesser amount of active ingredient. A series of laboratory tests were performed to compare the acute toxicity of technical grade fenthion, Baytex fog (65% diesel fuel, 33.5% fog oil of light naphthenics and 1.5% fenthion), and the oil carriers alone to a variety of non-target estuarine organisms. Toxicity tests were performed on hatching eggs and juveniles of the spotter seatrout (Cynoscion nebulosus) and the common snook (Centropomus undecimalis), hatching eggs of spot (Leiostomus xanthurus) and gulf menhaden (Brevoortia patronus), and adults of the calanoid copepod, Acartia tonsa. Fenthion alone

was toxic at higher concentrations than was fenthion in fog mixture. The 48 hr LC50s for technical grade fenthion were greater than 300 ng/mL, and in most cases above 1,000 ng/mL. Copepods were more sensitive to fenthion than most of the fish tested. Baytex fog (relative to fenthion concentration) was always more toxic than fenthion alone. The difference was significant for all animals tested except common snook juveniles. Acutely toxic concentrations of Baytex fog were lowest for seatrout and copepods (48 hr LC50s < 10 ng/mL fenthion), intermediate for newly hatched snook and spot (48 hr LC50s = 10 to 100 ng/mL fenthion), and highest for snook juveniles and hatching menhaden (48 hr LC50 > 100 ng/mL fenthion. Lethality observed with Baytex fog was matched by that of the oil mixture controls; LC50s for oil alone were very near, if not the same as LC50s for oil in Baytex fog. It appears that the toxicity of Baytex fog to non-target organisms resulted mostly from the presence of oil. (VerNooy-PTT)
W90-03432

INVESTIGATION OF CORRELATION BETWEEN PHYSICOCHEMICAL PROPERTIES OF METALS AND THEIR TOXICITY TO THE WATER FLEA DAPHNIA MAGNA STRAUS.
Industrial Toxicology Research Centre, Lucknow (India).
B. S. Khangarot, and P. K. Ray.
Ecotoxicology and Environmental Safety EESADV, Vol. 18, No. 2, p 109-120, October 1989. 4 tab, 60 ref.

Descriptors: *Heavy metals, *Toxicity, *Daphnia, *Physicochemical properties, *Water pollution effects, Correlation analysis, Cations, Mathematical analysis, Statistical analysis, Data interpretation.

Twenty-three metal ions were tested and ranked in terms of decrease in immobilization (EC50) of Daphnia magna Straus. The 48-hr EC50 values (mg/L) of metal ions were Hg(++), 0.0052; Ag(+), 0.01; Cu(++), 0.093; Zn(++), 0.56; Co(++), 1.49; Cr(6+), 1.79; Cd(++), 1.88; Be(++), 2.82; Pb(++), 3.61; As(3+), 6.23; Fe(++), 7.20; Ni(++), 7.29; Mn(++), 8.28; Sn(++), 21.56; Ba(++), 32.00; Al(3+), 59.60; W(6+), 89.39; Sr(++), 94.00; K(+), 141.46; Mg(++), 343.56; Na(+), 420.60; and Sb(3+), 423.45. The 48-hr EC50 values of 23 metal ions were transformed to their corresponding negative logarithms of molarity (as pM). Correlation coefficients for more than 35 physicochemical properties of metals or metal ions and acute toxicity values (as pM) were examined by linear regression analysis. The negative logarithm of the solubility product constant of metal sulfide, equilibrium constants of amino acids and of ethylenediamine tetraacetic acid (EDTA), nucleotide base, electronegativity, electrode potential, melting point, thermal properties of metals and other physicochemical parameters were significantly correlated with toxicity of D. magna. It appears that the toxicity of an element increases as its electronic stability decreases. Thus, the more active the element chemically, the more toxic it is. It appears that the periodic table, which classifies and foretells the physicochemical properties of elements, may be used to predict the toxicities of metallic compounds to living systems. Correlation between toxicity and physicochemical properties of inorganic substances may be useful in predicting toxicity of various biologically important organisms. (Author's abstract)
W90-03434

PREDICTION OF THE TOXICITY OF MIXTURES OF SHALE OIL COMPONENTS.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
M. S. J. Warne, D. W. Connell, D. W. Hawker, and G. Schuurmann.
Ecotoxicology and Environmental Safety EESADV, Vol. 18, No. 2, p 109-120, October 1989. 1 fig, 3 tab, 11 ref. Umweltbundsamt Project 106 04019/02.

Descriptors: *Toxicity, *Marine bacteria, *Oil shale, *Aromatic compounds, *Water pollution effects, *Bioassay, Synergistic effects, Growth rates,

Group 5C—Effects Of Pollution

Mathematical equations, Data interpretation, Benzenes, Naphthalene, Pyridine, Phenols, Hexene.

The toxicities of selected oil shale components and of mixtures of these components to a mixed marine bacterial culture have been determined. Cultures were used in a static bioassay procedure and concentrations of oil shale components that inhibited bacterial growth by 50 and/or 10% (EC50, EC10) were determined. The toxicities of mixtures whose components were members of the same homologous series were found to be additive. These mixtures included: benzene and alkyl benzene derivatives; benzene and naphthalene; 2-methyl and 2-ethylnaphthalene; pyridine and 2-alkyl pyridines; and phenol, 3-methyl, and 3-ethyl phenol. In all other cases, even when the compounds were as closely related as structural isomers (e.g. 2-ethyl and 3-ethyl phenol), synergism was observed. Simple and multiple linear regression equations utilizing measures of toxicity and molecular descriptors were used successfully to predict the enhancement of toxicity due to interaction of components in mixtures regardless of the mode of interaction. The methodology enables the prediction of the toxicity enhancement of mixtures with additive and synergistic interaction modes and possibly for all interaction modes, whereas the previous methods could only predict when mixtures would be additive. (Author's abstract)
W90-03435

ZINC ACCUMULATION IN FIDDLER CRABS UCA ANNULIPES LATREILLE AND UCA TRIANGULARIS (MILNE EDWARDS).
Mississippi Univ. Medical Center, Jackson. Dept. of Neurology.
For primary bibliographic entry see Field 5B.
W90-03436

CADMIUM NEPHROPATHY IN A FRESHWATER FISH, PUNTIUS CONCHONIUS HAMILTON.
Kumaun Univ., Naini Tal (India). Dept. of Zoology.
T. S. Gill, J. C. Pant, and H. Tewari.
Ecotoxicology and Environmental Safety EESADV, Vol. 18, No. 2, p 165-172, October 1989. 8 fig, 34 ref. Council of Scientific and Industrial Research, New Delhi Grant 8/26(9)/79 EMR I and University Grants Commission, New Delhi Grant 23-191/83 SR II.

Descriptors: *Cadmium, *Fish physiology, *Toxicity, *Animal pathology, *Water pollution effects, *Kidneys, Pathology, Tissue analysis.

Renal pathology was examined in a freshwater fish, Puntius conchonius, during a 12-week exposure to 500, 630, and 840 microg CdCl2/L (1/25, 1/20, and 1/15 fractions of the 96-hr TLm, respectively). Multifocal tubular epithelial degeneration including severe vacuolation and nuclear pyknosis and karyorrhexis composed the most obvious lesions. The degenerative changes were found mainly in the proximal segments, while the distal segments and the collecting tubules and ducts remained unaffected. Collapsed and shrunken glomeruli and swollen Bowman's spaces were also frequently observed. The severity of nephral injury is apparently dose-and time-dependent. Furthermore, these deleterious effects of cadmium are qualitatively similar to those described in other bony fishes and higher vertebrates, differences in the metal concentrations used and the exposure periods notwithstanding. The cadmium-exposed fish appeared heavily stressed and moribund. (Author's abstract)
W90-03437

EFFECTS OF CADMIUM AND PCBS ON REPRODUCTION OF THE SEA STAR ASTERIAS RUBENS: ABERRATIONS IN THE EARLY DEVELOPMENT.
Utrecht Rijksuniversiteit (Netherlands). Research Group for Aquatic Toxicology.
P. J. den Besten, H. J. Herwig, D. I. Zandee, and P. A. Voogt.
Ecotoxicology and Environmental Safety EESADV, Vol. 18, No. 2, p 173-180, October 1989. 4 fig, 2 tab, 22 ref.

Descriptors: *Cadmium, *Polychlorinated biphenyls, *Echinoderms, *Life cycles, *Water pollution effects, *Toxicity, Embryonic growth stage, Morbidity, Estuarine environment.

In semifield experiments sea stars, Asterias rubens, were exposed to 25 microg Cd/L or fed with mussels containing 0.6 microg/g wet weight PCBs (Clophen A50). After 5 months of exposure, Cd concentrations in testes and ovaries were respectively 17 and 50 times higher (0.15 and 0.70 microg Cd/d dry weight) than those in unexposed sea stars. PCB concentrations were respectively 7 and 9 times higher (0.73 and 1.62 microg Cd). With spermatozoa obtained from Cd or PCB exposed sea stars, normal fertilization could be achieved. However, maturation of oocytes from Cd-exposed animals was delayed and early development of embryos from Cd or PCB exposed animals was disturbed. Due to aberrations during the early development only 24 and 30% of the embryos obtained from Cd or PCB exposed sea stars, respectively, had developed to normal bipinnaria larvae after 1 week. From the results, it can be concluded that long-term exposure of sea stars to low levels of Cd or PCBs during the reproductive cycle affects the oocytes. Cd affected the maturation and both Cd and PCBs caused aberrations in the early embryonic development. (Author's abstract)
W90-03438

BIOTRANSFORMATION AND OTHER PHYSIOLOGICAL RESPONSES IN WHITEFISH CAGED IN A LAKE RECEIVING PULP AND PAPER MILL EFFLUENTS.
Kuopio Univ. (Finland). Dept. of Physiology.
P. Lindstrom-Seppa, and A. Oikari.
Ecotoxicology and Environmental Safety EESADV, Vol. 18, No. 2, p 191-203, October 1989. 2 fig, 5 tab, 33 ref. The Academy of Finland/ Research Council of the Environmental Sciences Project 06/085.

Descriptors: *Fish physiology, *Biotransformation, *Whitefish, *Pulp and paper industry, *Water pollution effects, Effluents, Lakes, Enzymes, Metabolism, Toxicity, Phenols, Path of pollutants, Industrial wastes, Bioindicators.

Hepatic monooxygenase (MO) and conjugation enzyme activities, metabolites of chlorinated phenolics in the bile, and blood ionoregulatory parameters were studied in juvenile whitefish (Coregonus muksun Pallas and C. muksun x Coregonus peled Gmelin hybrid) held in cages downstream from a mill producing chlorine-bleached kraft pulp and printing paper. MO activities, measured as benzo(a)pyrene hydroxylase, 7-ethoxycoumarin O-deethylase, and 7-ethoxyresorufin O-deethylase, were significantly induced in whitefish caged about 5 km from the effluent outlet. The highest mean increase detected was 17 times the control value. In the nearest caging station (3 km) the induction was lower, indicating inhibition or toxicity caused by the effluent. The levels of bile metabolites of chlorinated phenolics showed highest concentrations at the nearest station and decreased levels at more distant locations over the whole water area studied (15 km). Bile metabolites in whitefish exposed in control areas confirmed low-level background pollution of the lake system due to chlorinated phenolics. Observations on blood ionic concentrations suggest that whitefish were able to regulate their hydromineral balance despite the environmental pollution affecting physiology of biotransformation. (Author's abstract)
W90-03439

EFFECTS OF CRUDE OIL ON THE AIR-BREATHING ORGANS OF THE STRIPED GOURAMI, COLISA FASCIATUS: A SEM STUDY.
Bihar Univ., Muzaffarpur (India). Dept. of Zoology.
M. S. Prasad.
Ecotoxicology and Environmental Safety EESADV, Vol. 18, No. 2, p 211-218, October 1989. 7 fig, 16 ref.

Descriptors: *Water pollution effects, *Fish physiology, *Gills, *Oil pollution, *Animal pathology, Electron microscopy, Toxicity, Oil, Pathology, Tissue analysis.

Pathological effects of crude oil on the air-breathing organs of the striped gourami, Colisa fasciatus, were studied using scanning electron microscopy (SEM). Groups of five fish (average weight = 1.8 g) were exposed to either 100, 200, 300, 400, or 500 ppm crude oil from Barauni (Bihar) oil refiners for 12 hr to 15 days. Each experimental group was accompanied by two replicas and a control, and test solutions were changed after every 24 hr. Buccal epithelium appeared to be more sensitive to crude oil than epithelia of the suprabranchial chamber and the labyrinthine organ. Lower doses of crude oil (200 to 300 ppm) caused mucous cell hyperplasia, shrinkage of respiratory epithelium, and telangiectasis of blood capillaries in the air-breathing organs. After exposure of the fish for 7 days to 100 ppm, almost no departure from the architectural patterns of the epithelium occurred compared to that of the control. Manifestations of lethal pathological effects including mucous cell hypertrophy, lesions, and sloughing of air epithelium increased with increasing crude oil concentration and exposure period. (Author's abstract)
W90-03441

RENAL LESIONS IN ESTUARINE FISHES COLLECTED FROM THE ELIZABETH RIVER, VIRGINIA.
William and Mary Coll., Gloucester Point, VA. Inst. of Marine Science.
A. Thiyagarajah, D. E. Zwerner, and W. J. Hargis.
Journal of Environmental Pathology, Toxicology and Oncology JEPOEC, Vol. 9, No. 3, p 261-268, May/June 1989. 2 fig, 1 tab, 19 ref.

Descriptors: *Toxicity, *Estuarine fisheries, *Water pollution effects, *Hydrocarbons, *Stream pollution, *Fish physiology, Kidneys, Animal pathology, Stream fisheries, Sublethal effects.

The renal lesions of five species of estuarine fishes from the heavily polluted Elizabeth River, VA, and the nearby, less polluted Nansemond River were studied grossly and microscopically. Hogchoker (Trinectes maculatus), oyster toadfish (Opsanus tau), spot (Leiostomus xanthurus), Atlantic croaker (Micropogonias undulatus), and weakfish (Cynoscian regalis) were collected by otter trawl in October 1986. No gross lesions were observed but microscopic lesions occurred in renal tissue. Mesangial sclerosis occurred in hogchoker, and a mesangiolysis occurred in both hogchoker and spot. Glomerular lesions in spot and hogchoker were more frequent in Elizabeth River samples than in Nansemond River samples. Tubular lesions occurred on both Nansemond River and Elizabeth River sciaenids and hogchoker; the prevalence of these lesions was higher in Elizabeth River sciaenids but equal in hogchoker. All lesions in toadfish were found only in fish from the Elizabeth River. In an earlier study, analyses of sediments from these rivers revealed the presence of petroleum chemicals, but the concentration of these chemicals are at least four-fold higher in the Elizabeth River than in the Nansemond River. Mesangial lesions, tubular necrosis, and degenerative changes seem to be indicative of the effects of pollutants on the kidneys of Elizabeth River fish. However, other etiological factors as possible causes of these conditions cannot be eliminated. (Author's abstract)
W90-03445

CADMIUM EXPOSURE OF RAINBOW TROUT, SALMO GAIRDNERI RICHARDSON: EFFECTS ON IMMUNE FUNCTIONS.
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Pathology.
A. Thuvander.
Journal of Fish Biology JFIBA9, Vol. 35, No. 4, p 521-529, October 1989. 2 fig, 2 tab, 24 ref.

Descriptors: *Water pollution effects, *Fish physiology, *Cadmium, *Rainbow trout, *Immunology, *Heavy metals, Fish, Sublethal effects, Antibodies, Tissue analysis, Bioassay.

Differential leucoctye counts, phagocytosis, humoral antibody response and the in vitro blastogenetic response to mitogens (lipopolysaccharide and Concanavalin A) and to an antigen (Vibrio anguillarum) were studied in rainbow trout exposed to 0, 0.7, or 3.6 microg Cd/L for 12 weeks. Although the fish did not exhibit any clinical or histological changes, cadmium exposure was found to affect two of the immune parameters measured. The cellular response of fish immunized with V. anguillarum to the homologous antigen was significantly lower for splenocytes obtained from fish exposed to cadmium for 9 weeks (3.6 microg Cd/L group) than for splenocytes obtained from non-exposed fish. Conversely, the humoral antibody response to V. anguillarum O-antigen was higher in the 3.6 microg Cd/L group than in the non-exposed group. Protective immunity of fish vaccinated against V. anguillarum was equally as good in the cadmium-exposed group as in the non-exposed group. No cadmium-induced changes in differential leucocyte count or in the proportions of phagocytic cells were observed. (Author's abstract)
W90-03447

GROWTH OF JUVENILE ATLANTIC SALMON, SALMO SALAR L., AND BROWN TROUT, SALMO TRUTTA L., IN A SCOTTISH RIVER SYSTEM SUBJECT TO COOLING-WATER DISCHARGE.
Freshwater Fisheries Lab., Pitlochry (Scotland).
B. R. S. Morrison.
Journal of Fish Biology JFIBA9, Vol. 35, No. 4, p 539-556, Oct 1989. 4 fig, 10 tab, 13 ref.

Descriptors: *Growth rates, *Trout, *Salmon, *Thermal pollution, *Water pollution effects, *Temperature effects, *Stream fisheries, *Scotland, Water temperature, Fish migration, Industrial water, Fish populations.

The River Fiddich, a tributary of the River Spey in northeast Scotland, is a spawning river for both Atlantic salmon and brown trout. Warm cooling water effluent is discharged from several distilleries at different points in the lower reaches and raises the temperature of the river 1 to 3 C above ambient for most of the year. Salmon and trout grow more rapidly in this region than further upstream, and juvenile salmon generally migrate a year earlier, as 2+ smolts. Available data were too few to determine whether there was also a difference for trout. Similar studies on the River Dullan, a tributary of the Fiddich, and on the Cromdale Burn in the same area, confirmed that the growth rate of fish is faster downstream from distillery discharge points. It is suggested that increased invertebrate production may influence the growth rate. (Author's abstract)
W90-03448

INFLUENCE OF DIETARY AND WATER-BORNE ZINC ON HEAT-STABLE METAL LIGANDS IN RAINBOW TROUT, SALMO GAIRDNERI RICHARDSON: QUANTIFICATION BY (109)CD RADIOASSAY AND EVALUATION OF THE ASSAY.
McMaster Univ., Hamilton (Ontario). Dept. of Biology.
D. J. Spry, and C. M. Wood.
Journal of Fish Biology JFIBA9, Vol. 35, No. 4, p 57-576, October 1989. 9 fig, 3 tab, 55 ref.

Descriptors: *Water pollution effects, *Trout, *Fish physiology, *Zinc, *Cadmium radioisotopes, Fish diets, Fish, Bioassay, Biochemical tests, Tissue analysis.

The Cd binding of Eaton and Toal was critically evaluated and then used to assess the induction of cytosolic metal-binding ligands in rainbow trout exposed to Zn in the diet and/or in the water for 16 weeks. With purified rabbit Cd-Zn metallothionein (MT), (109)Cd binding and total Cd recovery in the assay were linear up to 5 microg of protein; gel chromatography revealed a single peak. With heat-denatured extracts of gill, liver and intestine from control and Cd and Zn injected trout, (109)Cd binding was generally linear with sample size. Gel chromatography demonstrated that (109)Cd was bound by a protein with the same

apparent weight as MT (approx 11,000 daltons), but significant binding occurred also at three other regions (molecular weight > 70,000, 30,000, and < 3,000). In the dietary waterborne Zn exposure, induced (109)Cd-binding activity occurred not in the MT peak, but in the low molecular weight peak (< 3000). Activity in the gill rose in response to both dietary and waterborne Zn, but the liver did not respond. The maximum five-fold elevation in the gill was primarily a waterborne effect. In the intestine, the maximum rise was 25-fold due to both factors. Thresholds for induction were > 39 microg Zn/L in water, and > 90 mg/kg in the diet, but only when waterborne Zn was also high. There was no correlation between (109)Cd binding and acid soluble thiol levels, which tended to decline at higher Zn exposures. (Author's abstract)
W90-03449

SALINITY AND TOXICITY OF QUINALPHOS ON THE BLACK CLAM VILLORITA CYPRINOIDES VAR. COCHINENSIS (HANLEY).
Cochin Univ. of Science and Technology (India). School of Marine Sciences.
J. P. Jacob, and N. R. Menon.
Bulletin of the Department of Marine Sciences University of Cochin, Vol. 14, p 39-45, 1986-88. 2 fig, 14 ref.

Descriptors: *Bioassay, *Water pollution effects, *Pesticides, *Toxicity, *Organophosphorus pesticides, *Clams, Salinity, Quinalphos.

Villorita cyprinoides var. cochinensis popularly known as black clams were exposed to various concentrations of Quinalphos R an organophosphate pesticide, at varying salinities ranging from 0.005 to 0.03. The 96h LC50 calculated from these static bioassays ranged from 10.5 ppm at 0.005 S to 2.7 ppm at 0.030 S. The effective time to kill 50% of the animals (ET50) for different pesticide concentrations also showed a decrease with increase in salinity. The clams showed maximum tolerance to quinalphos in salinities ranging from 0.005 to 0.02, the normal habitat of the animals. (Author's abstract)
W90-03453

EXPERIMENTS EVALUATIONS OF THE MYSID HOLMESIMYSIS COSTATA AS A TEST ORGANISM FOR EFFLUENT TOXICITY TESTING.
California State Dept. of Fish and Game, Monterey. Marine Pollution Studies Lab.
For primary bibliographic entry see Field 5A.
W90-03462

BIOAVAILABILITY OF SEDIMENT-SORBED AND AQUEOUS SURFACTANTS TO CHIRONOMUS RIPARIUS (MIDGE).
Procter and Gamble Co., Cincinnati, OH. Ivorydale Technical Center.
For primary bibliographic entry see Field 5B.
W90-03464

MEASURING THE ACUTE TOXICITY OF ESTUARINE SEDIMENTS.
Oregon State Univ., Newport. Hatfield Marine Science Center.
T. H. DeWitt, R. C. Swartz, and J. O. Lamberson.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 11, p 1035-1048, 1989. 4 fig, 6 tab, 56 ref. EPA Cooperative Agreement No, CR814-151-01-0.

Descriptors: *Water pollution effects, *Toxicity, *Estuarine sediments, *Bioindicators, *Polycyclic aromatic hydrocarbons, Amphipods, Salinity, Fluoranthene.

Estuarine sediments frequently are repositories and sources of anthropogenic contaminants. Toxicity is one method of assessing the environmental quality of sediments, yet because of the extreme range of salinities that characterize estuaries few infaunal organism have both the physiological tolerance and sensitivity to chemical contaminants to serve in estuarine sediment toxicity tests. Research is described on the estuarine burrowing amphipod,

Eohaustorius estuaries Bosworth, 1973, whose survival was >/= 95% in control sediments across a 2 to 28% salinity range over 10-d periods. E. estuarius also was acutely sensitive to low sediment concentrations of the polycyclic aromatic hydrocarbon, fluoranthene (LC50 approx = 10.6 mg/kg), and its sensitivity to fluoranthene was not affected by salinity. E. estuarius was almost as sensitive as Rhepoxynius abronius to fluoranthene and to field-collected sediments from Puget Sound urban and industrial bays. E. estuarius was also more tolerant of very fine, uncontaminated sediments than R. abronius. Furthermore, E. estuarius was more sensitive to sediments spiked with fluoranthene than the freshwater amphipod, Hyalella azteca. E. estuarius, and possibly other estuarine haustoriid species, appears to be an excellent candidate for testing the acute toxicity of estuarine and marine sediments. (Author's abstract)
W90-03465

GLUTATHIONE-DEPENDENT METABOLISM IN FISH AND RODENTS.
Minnesota Univ.-Duluth. Dept. of Pharmacology.
K. B. Wallace.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 11, p 1049-1055, 1989. 4 tab, 28 ref.

Descriptors: *Bioindicators, *Toxicity, *Fathead minnows, *Trout, *Fish physiology, *Detoxification, Rodents, Enzymes.

Hepatic glutathione (GSH) concentration was significantly higher in rats and mice compared to either fathead minnows or rainbow trout. In rodents, the concentration of GSH approximated the Km of hepatic glutathione peroxidase (GPx), whereas in fish GSH concentration was less than the Km of GPx. The significantly lower Km for oxidized glutathione (GSSG) of glutathione reductase compared to the Km for GSH of the peroxidase is consistent with the large ratio of reduced-to-oxidized glutathione in all four species. The concentration of GSH in rodent liver far exceeds the Km for hepatic glutathione-S-transferase (GST), which contrasts with that observed for fish. Furthermore, the greater activity of renal gamma-glutamyl transpeptidase in rodents compared to fish suggests that, once formed, glutathione conjugates are rapidly hydrolyzed, leading to greater mercapturic acid production in rats and mice. Collectively, these data suggest that rodents are quite capable of conducting GSH-dependent detoxification of prooxidants and electrophiles, whereas in fish GSH-dependent metabolism appears to be self-limited by the availability of endogenous GSH. Accordingly, the data suggest that fish may be disproportionately more susceptible than rodents to xenobiotics that are eliminated principally by GSH-dependent metabolic detoxification. (Author's abstract)
W90-03466

MULTITROPHIC LAKE EVALUATION OF SEDIMENT TOXICITY IN WAUKEGAN AND INDIANA HARBORS.
Wright State Univ., Dayton, OH. Dept. of Biological Sciences.
G. Allen Burton, B. L. Stemmer, K. L. Winks, P. E. Ross, and L. C. Burnett.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 11, p 1057-1066, 1989. 7 tab, 54 ref.

Descriptors: *Lake Michigan, *Bioindicators, *Sediment contamination, *Water pollution effects, *Toxicity, Waukegan Harbor, Indiana Harbor, Microbiological studies, Lakes.

The toxicity of sediments from three Waukegan Harbor sites, two Indiana Harbor sites and one reference site (Homer Lake) were evaluated using a multitrophic level test battery. The test battery consisted of the following assays: Daphnia magna 48-h survival, Ceriodaphnia dubia 48-h survival, Hyalella azteca 48-h survival, selenastrum capricornutum 48-h growth inhibition and enzymatic activity of the indigenous microbial community (alkaline phosphatase, electron transport system

activity, beta-galactosidase and beta-glucosidase). All assays, with the exception of S. capricornutum, were conducted using both whole sediments and elutriate (water-extractable) fractions. The test battery effectively discriminated between sites in most cases. However, response patterns varied slightly between macrofaunal and microbial responses and between whole sediment and elutriate phase responses. C. dubia was the most sensitive and H. azteca the least sensitive macrofaunal test species. Microbial community assays showed a greater range of responses, thus providing for greater discrimination between test sites. beta-Galactosidase and beta-glucosidase were the most sensitive microbial assays. The acute toxicity response patterns verified sites containing the highest levels of contaminants at Waukegan Harbor and detected contamination in Indiana Harbor. Differences between degree and/or pattern of response and whole sediments versus elutriate toxicity patterns demonstrated both the usefulness and necessity of a multitrophic level toxicity test battery in sediment quality assessment. (Author's abstract)
W90-03467

EVALUATION OF THE FATHEAD MINNOW SEVEN-DAY SUBCHRONIC TEST FOR ESTIMATING CHRONIC TOXICITY.
Environmental Research Lab., Duluth, MN.
For primary bibliographic entry see Field 5A.
W90-03468

EFFECT OF TREATED RUM DISTILLERY EFFLUENTS ON THE DISTRIBUTION AND SURVIVAL OF POTENTIAL BACTERIAL PATHOGENS.
Puerto Rico Univ., Rio Piedras. Microbial Ecology Lab.
T. Hazen, and G. Toranzos.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-107012/AS, price codes: A06 in paper copy, A01 in microfiche. Final Technical Report, Puerto Rico Water Resources Research Institute, Mayaguez, February 1987. 94p, 22 fig, 26 tab, 61 ref. USGS Contract 14-08-0001-G930. USGS Project G930-03.

Descriptors: *Water pollution effects, *Fate of pollutants, *Fermentation, *Puerto Rico, *Rum distillation, *Pathogenic bacteria, *Wastewater treatment, *Methane, *Anaerobic digestion, Industrial wastes, Waste disposal, Environmental effects.

The efficiency of the methane anaerobic digestion treatment on rum distillery effluents and its capacity to change population of potentially pathogenic bacteria was determined. BOD, COD and limiting nutrient concentrations were equal or higher in treated effluents than in untreated rum effluents. Viable bacteria were negatively correlated with sulfates and sugar concentration. Total bacterial densities were higher in treated effluents, however, a large proportion of these bacteria were anaerobic methane bacteria responsible for early effluent transformation. There was no difference in species diversity between treatment levels. Aeromonas and Citrobacter were the main genera of the aerobic and facultative anaerobic communities, since they are also the acetic acid producers of the digestion process. Vibrio cholerae was inoculated to microcosms with treated and untreated effluent under controlled conditions. Temperatures and pH were the most critical parameters influencing bacterial density and metabolism. Vibrio cholerae in treated rum distillery effluents had lower densities and metabolic activity. Vibrio cholerae submitted to a survival study under non-controlled conditions at both treatment levels showed no significant differences in survival or activity. Survival rates were higher than those earlier reported for ambient waters. It was concluded that methane anaerobic digestion treatment fails to reduce BOD and COD levels significantly in rum distillery effluents in terms of its effect on the environment, and there is no difference in treated and untreated effluents in terms of growth and survival of potentially pathogenic bacteria. Methane digestion treatment alone was shown to be insufficient in reducing the potential hazard of rum distillery effluents to the environment and/or public health. (Hazen-Puerto Rico WRRI)

W90-03560

5D. Waste Treatment Processes

USE OF MODIFIED CLAYS FOR THE REMOVAL AND DISPOSAL OF CHLORINATED DIOXINS AND OTHER PRIORITY POLLUTANTS FROM INDUSTRIAL WASTEWATERS.
Michigan Univ., Ann Arbor. Dept. of Chemical Engineering.
K. R. Srinivasan, and H. S. Fogler.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 333-342, 1989. 10 fig, 2 tab, 24 ref. EPA Grant R812555-010, and DOE/PETC Grant DE-FG22-87PC79918.

Descriptors: *Dioxins, *Wastewater treatment, *Aromatic compounds, *Dioxins, *Organic compounds, *Chemical wastes, *Water pollution treatment, *Industrial wastes, *Clays, Sorption, Contact beds.

The dynamics of adsorption and elution of octachlorodibenzodioxin (OCDD) on modified clay adsorbents was studied. In batch type experiments, a rapid approach to sorption equilibrium (within hours) as well as a Freudlich type sorption isotherm were noted. In packed bed sorption experiments using a step input of adsorbate concentration, no breakthrough was observed under a variety of volumetric flow rates, suggesting multilayer adsorption of dioxins on modified clay sorbents. Elution of sorbed dioxin with carrier solvent tetrahydrofuran (THF) exhibited two peaks indicating heterogeneity of modified clay sorbents. Finally, successive sorption/elution/sorption experiments revealed that modified clay sorbents can be regenerated and reused. (Author's abstract)
W90-02600

CHEMICAL DETOXIFICATION OF DIOXIN-CONTAMINATED WASTES USING POTASSIUM POLYETHYLENE GLYCOLATE.
Environmental Protection Agency, Seattle, WA. Surveillance and Analysis Div.
P. E. desRosiers.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 343-353, 1989. 1 fig, 10 tab, 15 ref.

Descriptors: *Water pollution treatment, *Dehalogenation, *Pentachlorophenol, *Wastewater treatment, *Detoxification, *Industrial wastes, *Chemical wastes, *Oil wastes, Organic compounds, Groundwater pollution, Bioassay, Polyethylene glycolate.

A chemical destruction technique known as KPEG (potassium polyethylene glycolate) was used successfully in the states of Montana and Washington to detoxify pentachlorophenol (PCP)-oil and spent solvent waste contaminated with dioxin. A mobile treatment unit, mounted on a 45-foot trailer, was employed to process 8,650 gallons of PCP wood-treating chemical waste at the Montana Pole site in Butte, Montana, in July 1986. This waste was generated as the oily phase of groundwater pumped from 21-foot deep recovery wells; after separation and decantation, approximately 3% PCP in light oil was obtained at the rate of 30 to 50 gallons per day. This site represents an inactive wood-treating facility located on a 20 acre, sloping, abandoned mining site, where contamination by dioxins (CDDs) and dibenzofurans (CDFs) has reached an adjacent creek, including groundwater and surface soil. The PCP-oil waste, containing CDD/CDF homologs, was processed in five batches. The treated oil was then pumped from the reactor into a holding tank from which composite samples were removed and sent for analysis. The chemistry of the destruction technique used employs two basic ingredients: potassium hydroxide and polyethylene glycol, which combine to form the reactive agent, KPEG. KPEG chemically removes chlorine atoms from the CDD molecule to form potassium chloride, thus rendering the dioxin molecule non-toxic. A battery of bioassay tests was used to ascertain whether KPEG byproducts (1) bioaccumulated in tissues of organisms, (2) caused cell mutations, or (3) caused immediate harm to fish or mammals.

There was no evidence that the byproducts were toxic in any of the tests performed. The KPEG process successfully destroyed CDDs and CDFs in waste PCP-oil. (Author's abstract)
W90-02601

FINE-PORE DIFFUSER RETROFIT AT RIDGEWOOD, NEW JERSEY.
Manhattan Coll., Bronx, NY. Environmental Engineering and Science Program.
J. A. Mueller, P. D. Saurer, and J. L. Lagrosa.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 115, No. 5, p 891-909, October 1989. 15 fig, 5 tab, 10 ref.

Descriptors: *Biological wastewater treatment, Wastewater facilities, *New Jersey, *Wastewater treatment, *Activated sludge process, *Aeration, Fine-pore diffuser, Coarse-bubble aeration, Nitrification, Economic aspects.

The Ridgewood Wastewater Treatment Plant in Ridgewood, New Jersey underwent a retrofit from a coarse-bubble to fine-pore aeration system. Also, process modification from contact stabilization to tapered air occurred. A significant improvement in effluent quality with respect to nitrification occurred after plant retrofit, where during summer months 85 to 95% nitrification could be obtained compared to none for the coarse-bubble system. Oxygen transfer efficiency of the fine pore system was approximately double that of the coarse bubble system. However, power costs were not reduced proportionately since a higher oxygen demand was supplied by the fine pore system to attain nitrification and meet the revised permit requirements. Severe nocardia foaming problems were encountered in the summer during the first three years of the fine pore operation. These were controlled in the last two years by minimizing sludge recycle loads and preventing septic conditions in the aeration tanks. Both off-gas and non-steady state testing appear reliable at Ridgewood, the off-gas testing providing oxygen transfer efficiencies at specific locations in the tank, while the non-steady state testing provides only an overall average tank value. (Author's abstract)
W90-02716

DYNAMIC MODEL OF NITRIFICATION IN FLUIDIZED BED.
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
D. K. Stevens, P. M. Berthouex, and T. W. Chapman.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 115, No. 5, p 910-929, October 1989. 7 fig, 4 tab, 42 ref.

Descriptors: *Wastewater treatment, *Nitrogen fixing bacteria, *Nitrification, *Biological wastewater treatment, *Fluidized bed process, Model studies, Fixed-film nitrification, Bed height, Mass transfer, Growth rates, Runge-Kutta integration technique.

Fixed-film nitrification was studied in a pilot-scale fluidized bed treating municipal secondary effluent. A mechanistic mathematical model incorporating reaction stoichiometry, diffusion, multisubstrate kinetics with product inhibition, fluidization, and a reactor model developed from the observed residence-time distribution, was developed to predict the steady-state and short-term dynamic performance of the reactor. The model equations were solved using orthogonal collocation with trial functions tailored to the spherical-shell biofilm geometry, and a semi-implicit third-order Runge-Kutta integration technique. The steady-state model closely fit measured concentration profiles using the maximum specific growth rates for Nitrosomonas and Nitrobacter as adjustable parameters. The dynamic model predicted observed responses to step and impulse changes in ammonium and nitrite concentration to within 3 mg/L without further parameter adjustment. The fluidization model predicted the observed fluidized bed height within 1 cm. External mass transfer resistance was small for the conditions employed and was not included in the model. (Author's abstract)

W90-02717

EFFECT OF POND DEPTH ON BACTERIAL MORTALITY RATE.
Dar es Salaam Univ. (Tanzania). Dept. of Civil Engineering.
A. W. Mayo.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 115, No. 5, p 964-977, October 1989. 4 fig, 7 tab, 24 ref.

Descriptors: *Fecal coliforms, *Stabilization ponds, *Bacteria, *Wastewater treatment, Water depth, Solar radiation, Mortality, Hydraulic retention.

The bacterial action of solar radiation was investigated in pilot scale waste stabilization ponds under the tropical climate of Dar es Salaam, Tanzania. Bacterial reduction was observed to proceed with increasing direct solar intensity and hydraulic detention time. The mortality rate of fecal coliforms used as test microorganisms was higher in samples incubated near the surface and decreased rapidly when the samples were incubated at greater depths in the pond. The disappearance rate of fecal coliforms for samples incubated at the pond surface was 1.66/d and at a depth of 1.0 m was 0.37/d. Fecal coliforms were also found to be reduced rapidly in shallow ponds. The mortality rate in 1.0 m deep ponds was 0.43/d and in 1.5 m deep ponds was 0.32/d. The die-off rate constant was observed to vary significantly with pond depth but was independent of hydraulic detention time. (Author's abstract)
W90-02720

MITIGATION OF BIOLOGICAL PROCESS UPSETS CAUSED BY ORGANIC INHIBITORS.
State Univ. of New York at Buffalo. Environmental Engineering Research Lab.
C. R. Lange, A. S. Weber, and M. R. Matsumoto.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 115, No. 5, p 1061-1065, October 1989. 2 fig, 2 tab, 9 ref.

Descriptors: *Biological wastewater treatment, *Wastewater treatment, *Organic inhibitors, Biomass, Chlorophenols, Process control, Reactor population, Cell residence time, Activated sludge process.

The physiological state of the reactor population and biomass concentration, which are important for mitigating the effects of short term exposure to organic inhibitors, were examined using 2-chlorophenol (2-CP) as a model inhibitory compound. To assess the effect of mean cell residence time on aerobic biodegradation of the synthetic wastewater in the presence of an inhibitor, oxygen uptake rate studies were conducted. The results indicated: (1) Cell physiology as determined by process mean cell residence time is an important factor affecting 2-CP toxicity with older bacteria apparently more resistant to 2-CP; (2) For a given 2-CP concentration, elevated biomass levels can moderate toxic inhibition; and (3) For 2-CP, cell physiology as determined by process mean cell residence time appears to be of greater importance in mitigating toxic inhibition than biomass concentration. While these results support the hypothesis that the factors studied are operative in mitigating inhibition, full scale activated sludge systems which employ solids recycle were shown in previous studies to have smaller reductions in process efficiency when subjected to shock organic loadings. (White-Reimer-PTT)
W90-02725

INDUSTRIAL PRETREATMENT: MAKING IT WORK.
T. Johnson.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 22, No. 5, p 21-25, September/October 1989. 4 fig, 2 tab.

Descriptors: *Pretreatment of wastewater, *Industrial wastes, *Wastewater treatment, *Metal-finishing wastes, Activated sludge process, Heavy metals, Pennsylvania.

The borough of Columbia is located on the Susquehanna River in Lancaster County, between York and Lancaster, Pennsylvania. Manufacturing processes used by industries in Columbia are (1) metal extractions from slag and metal upgrades, (2) smelting and refining of non-ferrous scrap metal, (3) green sand casting of malleable iron and hot dip galvanizing, (4) gray iron foundry and casting of gray iron, (5) making small motors and aluminum forming, and (6) metal machining of valve components. The Columbia wastewater-treatment plant is a 2.0 mgd activated-sludge plant with phosphorus removal and aerobic solids digestion. Average concentrations of lead, zinc, copper, and nickel in the sludge exceeded the maximum allowed. After discussions between borough officials and industry representatives, an agreement was worked out. While industrial monitoring showed diminished concentration of the metals, most samples remained above the borough's local limits. Confronted with this evidence, each industry worked with the borough to remedy what were basically poor housekeeping practices and eliminated high metal concentrations in the sludge. (Cutty-PTT)
W90-02732

CONSTRUCTED WETLANDS FOR SEWAGE TREATMENT: AN OVERVIEW.
T. Meehan.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 22, No. 5, p 37-42, September/October 1989. 4 fig, 8 ref.

Descriptors: *Wastewater treatment, *Artificial wetlands, *Domestic wastes, *Wetlands, Costs, Wildlife habitats, Aesthetics, Design criteria.

Constructed Wetlands for sewage treatment provide a practical alternative to conventional treatment of domestic wastewater from small communities, residences, and industries. Constructed wetlands treatment systems (CWTs) offer several advantages over conventional technology, including lower capital, operating, and maintenance costs; ease of operation; reliable, efficient treatment; flexibility for load variations; and various indirect benefits, such as wildlife habitat and pleasing aesthetics. Disadvantages include large land requirements, lack of design guidelines, and unfamiliarity by consulting engineers. There are, however, numerous constructed wetlands in successful operation. (Cutty-PTT)
W90-02733

CONTRACT OPERATIONS: ONE YEAR LATER.
J. Couch, D. Merrill, and E. Tacha.
Public Works PUWOAH, Vol. 120, No. 10, p 108-110, September 1989. 4 fig.

Descriptors: *Management planning, *Wastewater facilities, *Facilities management, Sludge management, Operating policies, Maintenance, Oklahoma City.

In 1988, Oklahoma City contracted out the operations, maintenance, and management of its North Canadian, Deer Creek, and Chisholm Creek wastewater treatment facilities, and a large pumping station, to Houston-based Professional Services Groups, Inc. The company is also responsible for sludge management and control. The agreement permitted operational changes and capital improvements to ensure the most efficient and cost-effective operation of the facilities. Consolidation of laboratory testing has led to economies not readily available before the take-over. Maintenance-related overtime has been minimized since the company assigns maintenance personnel to each facility as needed. Sludge processing was changed from the pre-watered lime-stabilization to the post-dewatered lime-stabilization process. During the first year of the contract, an ongoing preventive-maintenance program and intensive hands-on and classroom training programs were established. The North Canadian treatment facility was upgraded in 1988 to meet more stringent EPA regulations. (Cutty-PTT)
W90-02736

SURVIVAL OF PSEUDOMONAS PUTIDA UWCL CONTAINING CLONED CATABOLIC GENES IN A MODEL ACTIVATED-SLUDGE UNIT.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
N. C. McClure, A. J. Weightman, and J. C. Fry.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 10, p 2627-2634, 1989. 4 fig, 2 tab, 52 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Microbiological studies, *Pseudomonas, *Genetic engineering, Survival, Protozoa.

The possibility of the accidental or deliberate release of genetically engineered microorganisms into the environment has accentuated the need to study their survival in, and effect on, natural habitats. In this study, Pseudomonas putida UWCl harboring a non-self-transmissible plasmid, pD10, encoding the breakdown of 3-chlorobenzoate was shown to survive in a fully functioning laboratory-scale activated-sludge unit (ASU) for more than 8 weeks. The ASU maintained a healthy, diverse protozoal population throughout the experiment, and the introduced strain did not adversely affect the functioning of the unit. Although plasmid pD10 was stably maintained in the host bacterium, the introduced strain did not enhance the degradation of 3-chlorobenzoate in the ASU. When reisolated from the ASU, derivatives of strain UWCl(pD10) were identified which were able to transfer plasmid pD10 to a recipient strain, P. putida PaW340, indicating the in situ transfer of mobilizing plasmids from the indigenous population to the introduced strain. Results from plate filter matings showed that bacteria present in the activated-sludge population could act as recipients for plasmid pD10 and actively expressed genes carried on the plasmid. Some of these activated-sludge transconjugants gave higher rates of 3-chlorobenzoate breakdown than did strain UWCl(pD10) in batch culture. (Author's abstract)
W90-02790

DETERMINATION OF SULFONATED AZO DYES IN MUNICIPAL WASTEWATER BY ION SPRAY LIQUID CHROMATOGRAPHY TANDEM MASS SPECTROMETRY.
New York State Coll. of Veterinary Medicine, Ithaca.
For primary bibliographic entry see Field 5A.
W90-02812

EFFECTS OF THE APPLICATION OF WASTEWATER FROM OLIVE PROCESSING ON SOIL NITROGEN TRANSFORMATION.
Estacion Experimental del Zaidin, Granada (Spain). Dept. de Quimica Agricola.
J. D. Perez, and F. Gallardo-Lara.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 18, No. 9, p 1031-1039, Sep 1987. 3 fig, 15 ref.

Descriptors: *Nitrogen cycle, *Food-processing wastes, *Wastewater disposal, *Wastewater irrigation, *Industrial wastewater, Ammonium compounds, Nitrates, Waste disposal.

Vegetation water is the name given to wastewater from industrial extraction of olive oil. One possible solution to the waste disposal problems for olive oil producing industries is the use vegetation water as fertilizer. An incubation experiment was performed to study the effects of vegetation water on nitrogen transformation in a calcareous soil. The application of this wastewater was shown to decrease $NO_3(-)$ formation in comparison with control assays during approximately the first half of the experimental period (6 weeks). Results were similar although more marked when vegetation water plus ammoniacal nitrogen was applied as opposed to ammoniacal nitrogen alone. The incorporation of vegetation water during the initial phases of study also reduced soil $N-NH_4(+)$ levels both when residue only treatments were compared with controls and when vegetation water plus ammoniacal nitrogen treatments were compared with ammoniacal nitrogen only. (Author's abstract)

Group 5D—Waste Treatment Processes

W90-02834

SPECIFIC PROTEINS AND THEIR APPLICATION IN WASTEWATER TREATMENT.
Washington Univ., Seattle. Div. of Medical Genetics.
C. E. Furlong, J. A. Sundstrom, E. B. Weiler, P. W. Cheung, and J. Yin.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-119721. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-88/228, October 1988. 30p. 15 fig, 2 tab, 25 ref. EPA Contract CR811948.

Descriptors: *Adsorption, *Phosphates, *Proteins, *Wastewater treatment, *Biological wastewater treatment, *Phosphorus removal, Cadmium, Heavy metals, Phosphates, Bioreclamation, Zinc, Microbiological studies.

The feasibility of using immobilized proteins as highly specific adsorbers of pollutants in waste streams was tested. The Escherichia coli periplasmic phosphate-binding protein served as both a model system for determining the feasibility of such an approach and at the same time was used to produce a cycling ligand adsorber capable of efficiently scrubbing phosphate from a feed stream. Three different procedures for the removal of cadmium from feed streams were developed. One involved an immobilized metallothionein (a natural mammalian protein). The second involved an immobilized plant peptide. The third involved the synthesis of a resin that mimics the backbone structure of the naturally occurring plant peptides. This resin (termed 'Thiolex') binds cadmium with high affinity and with an approximate 20-fold preference over zinc. A bioreactor for continuous protein production was developed to minimize the cost of protein production. The bioreactor contained immobilized, non-growing E. coli cells. The cell line had been mutagenized and selected for the direct secretion of periplasmic proteins into the medium. The cells contained the gene that encodes the phosphate-binding protein. (Author's abstract)
W90-02915

ADSORPTION OF SR BY IMMOBILIZED MICROORGANISMS.
Oak Ridge National Lab., TN. Chemical Technology Div.
J. S. Watson, C. D. Scott, and B. D. Faison.
Available from the National Technical Information Service, Springfield, VA 22161. Price codes: A03 in paper copy, A01 in microfiche. Report No. CONF-880521--4, (1988). 118p, 2 fig, 3 tab, 6 ref. DOE Contract DE-AC05-84OR21400.

Descriptors: *Strontium, *Wastewater treatment, *Biological wastewater treatment, *Industrial wastewater, *Microorganisms, *Adsorption, Microbiological studies, Gels.

Wastewaters from numerous industrial and laboratory operations can contain toxic or undesirable components such as metal ions, which must be removed before discharge to surface waters. Adsorption processes that have high removal efficiencies are attractive methods for removing such contaminants. Selected microorganisms are potentially useful adsorbents for these applications because they can be inexpensive, have high selectivities, and have high capacities for adsorption of many heavy metals, which are often problems in a variety of industries. Microbial cells immobilized within bone gel particles can adsorb strontium (Sr) from dilute solutions. The specific ability to absorb Sr could have practical applications since it is an important pollutant in wastewaters from industries and laboratories handling nuclear materials. The adsorption is only partially attributed to the microbial cells; the gel itself is able to adsorb considerable Sr. M. luteus cells adsorb Sr very quickly, but the component(s) of the cells that contain the Sr appears to be slowly lost from the cells. The Sr released from the cells is likely to be associated with relatively high molecular weight materials that can neither enter nor escape from the gelatin. Although the apparent release of a Sr-bearing component from the cells complicates Sr adsorption by M. luteus cells, it may have little affect on

the usefulness of this organism for adsorption operations if the active adsorbing material is retained within immobilizing gels. The presence of other salts would reduce the adsorption of Sr, and moderately high concentrations can even been used to elute Sr from gel particles. Other commercial adsorbents are also able to remove Sr from such wastewaters. The practical application of Sr adsorption by immobilized cells in the treatment of wastewaters depends on the cost and stability of the gel particles. The potential for applying these adsorbents can be enhanced if improved organisms are found with even greater capacities and selectivities for Sr. (Lantz-PTT)
W90-02931

SORPTIVE REMOVAL OF TECHNETIUM FROM ALKALINE HEAVY METALS SLUDGE FILTRATE CONTAINING NITRATE ION.
Oak Ridge Gaseous Diffusion Plant, TN.
W. D. Bostick, and B. S. Evans-Brown.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-010156. Price codes: A02 in paper copy, A01 in microfiche. Report No. K/QT--160-P, (1988). 3p, 1 fig, 4 tab, 2 ref. DOE Contract DE-AC05-84OR21400.

Descriptors: *Radioactive wastes, *Wastewater treatment, *Sorption, *Heavy metals, *Sludge, *Technetium, *Nitrates, Iron, Sulfides, Resins, Filtration, Chemical treatment.

A so-called 'raffinate' waste stream is generated from various uranium recovery and equipment cleaning and decontamination activities at the X-705 facility of the Portsmouth (Ohio) Gaseous Diffusion Plant (PORTS). The day-to-day composition of this waste stream may be variable, but it is generally characterized by high concentrations of nitric acid, toxic heavy metals, and low levels of radioactive nuclides (235-U, 99-Tc). Current treatment protocol for the raffinate stream consists of the following: (1) dilution and pH adjustment (to a value of about 8.5) to precipitate the hydrolyzable heavy metals; (2) filtration to remove the heavy metals sludge (HMS); (3) processing of the filtrate with a strong-base anion exchange resin to remove the soluble pertechnetate (TcO4(-)) ion; (4) biodenitrification; and (5) sewage disposal. Cross-linked poly-4-vinyl-pyridine (PVP) resin (such as Reillex 402) is more efficient than strongly basic anion exchange resins for the removal of Tc in wastes containing high concentrations of nitrate ion. Inexpensive inorganic reagents such as elemental iron (degreased iron filings, about 40 mesh) and ferrous sulfide (in particular Greigite (Fe3S4)) were also found very efficient for the removal of Tc and also soluble mercury from aqueous nitrate wastes. (Lantz-PTT)
W90-02932

AERATION SYSTEMS: DESIGN, TESTING, OPERATION AND CONTROL.
Noyes Publications, Park Ridge, New Jersey. 1986. 452p.

Descriptors: *Oxygen transfer, *Aerators, *Wastewater treatment, Oxidation process, Aeration.

The protection of the environment is highly dependent upon the successful implementation of oxygen transfer. Several major problems face the industry--flexible designs are needed, with efficient systems under a variety of ever-changing conditions. The technology needs to be better defined and methods of testing applied. This book is the Proceedings of the Seminar Workshop on Aeration System Design, Testing, Operation, and Control held at the University of Wisconsin, Madison, Wisconsin in August 1982. The seminar was cosponsored by the U.S. Environmental Protection Agency and Environment Canada. The 24 papers cover such topics as characteristics of aeration systems, aeration system design, aeration system control, operation and maintenance of aeration systems, testing of the systems, and new directions for the future. (See W90-02939 thru W90-02962) (Mertz-PTT)
W90-02938

DIFFUSED AERATION--TYPES AND APPLICATIONS.
Water Pollution Control Corp., Milwaukce, WI.
J. D. Wren.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 8-15. 1 fig, 17 ref.

Descriptors: *Aeration, *Aerators, *Oxidation process, *Activated sludge process, *Wastewater treatment, Oxygen transfer.

There are two categories of diffused aeration--porous and non-porous. Porous diffusers are defined as being constructed of either natural ceramic or synthetic media and non-porous are designed for specific duties. They are constructed of metal and a variety of plastics and can be oriented horizontally or vertically, have single or multiple air release ports, fixed or variable area air flow passages, baffled or plain. Several types of systems are a combination of air diffusion and mechanical mixing. Systems such as jets, submerged turbines, and mechanically rotated air curtains or baffle walls are examples. The general function of all the devices in activated sludge aeration applications is to transfer oxygen, promote mixing of the oxygen with the aerated solids, promote flocculation, and resist deterioration of performance with time. In addition to activated sludge aeration, other unit processes employ diffused air. Some examples are pre and post aeration, liquid transfer channels, sludge digestion, sludge conditioning, aerated grid chambers, flow and load equalization tanks, and transfer of other gases such as ozone. (See also W90-02938) (Mertz-PTT)
W90-02939

MECHANICAL AERATION SYSTEMS--TYPES AND CHARACTERISTICS.
Rooke (T.D.) Associates Ltd., Toronto (Ontario).
T. D. Rooke.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 16-30. 6 fig.

Descriptors: *Aeration, *Oxidation process, *Aeration, *Wastewater treatment, Oxygen transfer.

Many types of mechanical devices have been invented for the purpose of aerating liquids. While it is possible to rank various aeration devices in order of energy efficiency under standard test conditions, the optimum selection of aeration equipment for a specific application must take into account other factors. Wastewater characteristics, oxygen uptake rate and turndown ratio, basin depth and climatic conditions can each have a significant impact on the final selection of the aeration system. Types of aeration devices include diffused air, mechanical aerators, and special aeration devices, such as trickling filters and rotating biological contactors. Mechanical aerators come is several varieties: low speed surface aerators, motor speed surface aerators, brush type surface aerators, down draft aerators, submerged turbine aerators, submersible aerators, and jet aerators. Aeration devices vary with respect to mixing, alpha factor, basin geometry constraints, ease of installation and maintenance, suitability for cold weather operation, cost, and energy efficiency. (See also W90-02938) (Mertz-PTT)
W90-02940

OXIDATION DITCH AERATION SYSTEMS--TYPES AND CHARACTERISTICS.
Envirex, Inc., Waukesha, WI.
G. W. Smith.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 31-46. 6 fig, 7 ref.

Descriptors: *Oxidation ditches, *Oxidation process, *Wastewater treatment, *Activated sludge process, *Aeration, *Aerators, Oxygen transfer, Mixing.

During the last ten years, the oxidation ditch aeration system has gained in popularity. Various types of basin configurations have been proposed

and used, along with numerous types of aerator/ mixing devices; the advantages and benefits claimed with these widely varying configurations and aerator/mixing devices have been very widespread and sometimes conflicting in nature, especially concerning advantages of oxygen transfer efficiency and nitrification/denitrification capabilities. The low-loaded activated sludge treatment modes associated with these systems do achieve consistent degrees of high treatment performance. Oxidation ditch systems do offer, because of their continuous flow circuits and uni-direction flow pattern, low-energy mixing requirements, resulting in more turn-down flexibility for both the small and large size treatment plants. (See also W90-02938) (Author's abstract)
W90-02941

TRANSLATION OF CLEAN TO DIRTY WATER OXYGEN TRANSFER RATES.
Rexnord, Inc., Milwaukee, WI.
M. L. Doyle, and W. C. Boyle.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 48-64. 6 fig, 2 tab, 37 ref.

Descriptors: *Oxygen transfer, *Wastewater treatment, *Aerators, *Aeration, Field tests, Oxidation process.

The translation of clean water oxygen transfer rates to field conditions represents a critical step in the design of aeration systems. The state of the practice in translation of clean to dirty water oxygen transfer rates is still in its infancy. With the escalation of energy costs, the need for efficient aeration systems is apparent. However, aeration system design appears to be lagging behind aeration device technology. Conservation over-design is not necessarily the answer since it may better refine design practice and specifications so that designs more closely fit field situations. Factors that affect dirty water performance include salinity (beta factor), temperature changes that change viscosity (theta factor), and a complex parameter (alpha factor) that is influenced by a number of process variables such as tank geometry, mixing of contaminant, and level of turbulence. Bench scale testing has not proved very satisfactory. From the viewpoint of accuracy and precision of testing under dirty water field conditions, radioactive tracer techniques and off gas methods offer great potential. This means that the profession must follow-up on designs with careful field evaluation. (See also W90-02938) (Mertz-PTT)
W90-02942

AERATION SYSTEM SCALE-UP.
Schmidtke (Norbert W.) and Associates Ltd., Kitchener (Ontario).
N. W. Schmidtke.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 65-84. 9 fig, 5 tab, 16 ref.

Descriptors: *Wastewater facilities, *Aeration, *Wastewater treatment, *Oxygen transfer, Mathematical analysis, Oxidation process.

Scale-up formulations for full-scale process design from data generated by way of prototype plant simulation at bench-scale have been the topic of many investigations. This is particularly true in the design of a variety of chemical engineering processes. Advances in this direction in the wastewater treatment process design field are few. Ability to predict full scale oxygen transfer capabilities of various aeration devices and systems from small scale systems has increased. But it is equally apparent that the amount of data scatter in investigations concerning system scale-up, lack of suitable field data for model validation is still formidable. There is little doubt that in order to minimize scale-effects between laboratory and prototype systems every attempt at attaining the goal of environmental, geometric, kinematic and dynamic similitude must be made. Successful scaling correlates directly with the degree to which this goal is attained. (See also W90-02938) (Mertz-PTT)
W90-02943

AERATION SYSTEM DESIGN PROTOCOLS: A NORTH AMERICAN PERSPECTIVE.
Alberta Univ., Edmonton. Dept. of Civil Engineering.
D. W. Smith.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 85-101. 7 fig, 4 tab, 20 ref.

Descriptors: *Biological wastewater treatment, *Aerators, *Aeration, *Wastewater treatment, *Wastewater facilities, Hydraulic loading, Oxygen transfer, Oxidation process.

Aeration system sizing for suspended growth systems requires careful evaluation of organic and hydraulic loading parameters. The development of models for suspended growth system performance prediction have taken two basic forms: experience based rules for design and operation, and rationally developed models for design and operation. For each of these approaches, the following basic informational components are required: organic loading and its variation with time, hydraulic loading and its variation with time, nutrient complement and its variation with time, and definition of the physical environment. The trend is toward improved understanding of the requirements of the biological systems and the aeration system. There is still a major problem with translating the results of testing an aeration system in one tank configuration and size to another. (See also W90-02938) (Mertz-PTT)
W90-02944

DESIGN PROTOCOL FOR AERATION SYSTEMS--UK PERSPECTIVE.
A. G. Boon, and B. Chambers.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 102-141. 4 fig, 3 tab, 15 ref. Append.

Descriptors: *Aerators, *Wastewater facilities, *Activated sludge process, *Biological wastewater treatment, Dissolved oxygen, England, Oxygen transfer, Aeration.

The successful design of an activated-sludge aeration system depends upon calculating the mass of oxygen that must be supplied to the process in order to produce an effluent of specified quality. Maximum aeration efficiency is achieved by taking into account the variations in oxygen demand that will occur and designing the aeration system to meet these requirements. Factors that must be considered include the effects of aeration tank geometry and aerator configuration on the performance of the overall aeration system. In order to achieve optimum aeration efficiency it is also necessary to match the supply of oxygen with demand such that excessive dissolved oxygen concentrations do not occur within the aeration tank. Recent surveys of aeration systems have shown that potentially the fine-bubble diffused-air system is capable of achieving high aeration efficiencies. Details of process modifications carried out at a large sewage treatment works in the UK to enhance the aeration efficiency of a fine-bubble system are given in an appendix. (See also W90-02938) (Author's abstract)
W90-02945

EXPERIENCES WITH DIFFERENT AERATION SYSTEMS IN GERMANY.
Technische Univ. Braunschweig (Germany, F.R.). Inst. fuer Stadtbauwesen.
R. Kayser.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 142-158. 10 fig, 4 tab, 14 ref.

Descriptors: *Germany, *Wastewater treatment, *Oxygen transfer, *Aerators, *Wastewater facilities, Aeration, Costs.

Results from measurements under process conditions of the oxygen transfer and the aeration efficiency, in conjunction with experiences with different aeration systems in use in Germany have been examined. It was found that the aeration efficiency of well-designed diffused air and surface aeration systems is of the order of 1.5 to 2.0 kg O2/

kiloWatthours, with the exception of diffused air in spiral flow tanks, which has a considerably lower aeration efficiency. For the selection of aeration systems numerous factors have to be considered. To chose between diffused air or surface aerators one must consider tank depth, climate, wastewater constituents that may clog diffusers, exhaust air treatment, oxygen supply needed, noise and spray problems, size of plant, and cost comparisons. Tank construction costs and the amount of oxygen transfer required are variables worth examining when choosing between vertical shaft or horizontal axis surface aerators. Finally, loading rates and process requirements must be weighed. Since denitrification must be considered in the future, circulation tanks with surface aerators may be preferable. (See also W90-02938) (Mertz-PTT)
W90-02946

IMPROVEMENT OF AIR DIFFUSION SYSTEMS APPLIED IN THE NETHERLANDS.
Technische Hogeschool Delft (Netherlands). Dept. of Civil Engineering.
J. H. Popel.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 159-179. 5 fig, 6 tab, 12 ref.

Descriptors: *Wastewater treatment, *The Netherlands, *Aerators, *Wastewater facilities, *Oxygen transfer, Aeration, Oxidation process, Performance evaluation, Model studies, Field tests.

Field tests with water on improved (uniform arrangement of diffusers or horizontal flow) air diffusion systems are reported and evaluated. Both improvements reduce the upward velocity of the water above the diffusors. Depending on this reduction, 4.5 to 7.7% oxygen absorption per m diffuser depth are obtained and 2.3 to 4.3 kg O2/ kiloWatthour oxygenation efficiency. Extreme efficiencies are mainly caused by low (40%) or high (60%) motor/blower efficiencies. Upward velocities were measured in one system. Their influence on oxygen transfer is modelled and applied to the other systems. Model results allows the assessment of whether further improvements of oxygen transfer and efficiency by changing the system design are possible. (See also W90-02938) (Author's abstract)
W90-02947

BLOWER DESIGN CONSIDERATIONS.
Gore and Storrie Ltd., Toronto (Ontario).
G. G. Powell.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 180-203. 18 fig, 1 ref.

Descriptors: *Aerators, *Aeration, *Wastewater facilities, *Wastewater treatment, Oxygen transfer, Costs, Design criteria.

A major design consideration in diffused aeration is the selection of the air blowers. Over the design life of a treatment facility the organic loading to the aeration tanks will vary significantly, creating both lower and higher oxygen demands. The aeration system which can efficiently meet this varying air requirement over the design period of the plant will realize a considerable cost savings. To select an efficient blower system properly the designer must appreciate not only the organic loading condition but also the performance characteristics of the blower used, its relationship to other blowers when running in parallel and its relationship to the air system. (See also W90-02938) (Author's abstract)
W90-02948

AUTOMATIC DISSOLVED OXYGEN CONTROL IN THE ACTIVATED SLUDGE PROCESS.
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
J. P. Stephenson.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 206-218. 3 fig, 33 ref.

Descriptors: *Aeration, *Aerators, *Oxygen transfer, *Wastewater treatment, *Activated sludge process, Biological wastewater treatment, Dissolved oxygen.

Dissolved oxygen control is necessary from the viewpoint of energy savings and moreover to improve the monitoring and operational control of these systems. Factors that govern the design and construction of aeration systems, particularly from a steady-state viewpoint include: mechanical design of the aeration system, hydraulic disturbances of the influent wastewater and return sludge, recycle from other process streams, changes in the feed pattern, organic load disturbances and substrate storage, nitrification/denitrification, mixing, changes in excess sludge wasting practices, and disturbances in the oxygen transfer efficiency. The hardware for aeration control in activated sludge systems exists and should be further exploited to improve plant operations. Although energy savings have been the dominant force behind aeration control, it is becoming recognized that other benefits, such as improved settleability, are derived from control. Estimation of respiration rate and the oxygen transfer coefficient within the process under time varying conditions is also possible. Digital processors must be used to obtain these estimates. With these measurements and tools it should prove to be possible to improve control over such other variables as sludge inventory. (See also W90-02938) (Mertz-PTT)
W90-02949

EVALUATION OF A DISSOLVED OXYGEN FIELD TEST PROTOCOL.
Environmental Protection Agency, Cincinnati, OH. Municipal Environmental Research Lab.
W. W. Schuk.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 219-242. 9 fig, 4 tab, 5 ref, append.

Descriptors: *Monitoring, *Water analysis, *Testing procedures, *Aerators, *Evaluation, Wastewater treatment, Oxygen transfer, Field tests, Comparison studies, Dissolved oxygen meters.

A test protocol which was developed for on-line dissolved oxygen meters was evaluated in a 60-day field test conducted in an activated sludge aeration basin with 13 meters from seven cooperating manufacturers. Results provide information on methods for testing, calibrating and performance monitoring, information useful for developing specifications, and information on routine maintenance for on-line dissolved oxygen meters in a specific plant environment. A critical performance requirement for on-line dissolved oxygen meters is to measure dissolved oxygen (within +/-0.5 ppm of O2) accurately with a mean time between maintenance (cleaning, calibration, etc.) of no less than 30 days. Of the meters tested by the developed protocol, nine meters from five manufacturers met the criteria. Of the four meters (two manufacturers) which did not meet the maintenance requirements, one manufacturer has an accessory component which, if made standard, may bring the meter into conformance with the protocol. The other manufacturer has an alternative model which may meet the protocol performance requirements. The study indicated that the developed protocol is appropriate for acceptance testing of on-line dissolved oxygen meters and that the state-of-the-art meters met the performance requirements of the protocol. (See also W90-02938) (Author's abstract)
W90-02950

CALIBRATION AND EVALUATION OF DISSOLVED OXYGEN SENSORS IN A PILOT SCALE ACTIVATED SLUDGE PLANT.
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
G. Speirs, D. Chapman, E. Luxon, and J. Matthews.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 243-260. 13 fig, 4 tab, 7 ref.

Descriptors: *Monitoring, *Activated sludge process, *Dissolved oxygen, *Instrumentation, *Aera-

tors, *Wastewater treatment, Comparison studies, Fouling, Performance evaluation, Oxygen transfer.

The performance of three types of dissolved oxygen sensors was evaluated in a pilot scale activated sludge plant. As the instruments were interfaced to a minicomputer, a curve fitting technique was developed to compensate for instrument nonlinearity. Weighted regression was performed to update initial calibrations. Fouling due to the microbial growth on the surface of the probe was the principal cause of decline in sensor performance with time. The rate of fouling depended on the type of sensor used, the mode of operation, the frequency of maintenance and the velocity of fluid past the probe. A number of alternatives were evaluated for reducing or compensating for the effects of fouling and other causes of inaccuracy. To determine the suitability of sensors for tracking dissolved oxygen concentration during non-steady state tests for determining overall mass transfer coefficients, the probes were subjected to repeated step changes in dissolved oxygen concentration. First-order time constants for the sensors were estimated based on the results of each step. The mean time constants for the probes tested were estimated to be less than 20 seconds in all cases. The dynamic response of a sensor without a membrane was much closer to that of a first-order system than was that of sensors with membranes. (See also W90-02938) (Mertz-PTT)
W90-02951

OPERATION AND MAINTENANCE OF CERAMIC FINE BUBBLE DIFFUSERS IN ACTIVATED SLUDGE SYSTEMS.
Houck (D.H.) Associates, Inc., Silver Spring, MD.
D. H. Houck.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 262-273. 6 fig, 4 ref.

Descriptors: *Aerators, *Cost analysis, *Aeration, *Wastewater treatment, *Wastewater facilities, England, Oxygen transfer.

Extensive experience in the United Kingdom with ceramic dome diffusers has shown them to be efficient and reliable when applied and operated properly. The key to effective use of this technology is understanding its design and operational boundaries. Aeration basin and inlet geometry is of prime importance in new or retrofitted plant design. Operators of these systems should be trained to spot the symptoms of impending problems and respond to them quickly. The cost incurred for additional maintenance is offset many times by the 200-300% improvements in electrical efficiency that can be realized over coarse bubble systems. Other advantages include lack of noise and airborne aerosols, and ease of plant sanitation. The savings in power costs, coupled with other operational advantages, have resulted in fine bubble ceramic grid systems becoming the system of choice in the U.K. North American plant designers and operators can expect the same benefits from this technology if they are willing to apply it correctly and benefit from the more than 20 years of overseas experience with ceramic fine bubble aeration systems. (See also W90-02938) (Mertz-PTT)
W90-02952

OPERATION AND MAINTENANCE OF AERATION SYSTEMS--AN OPERATOR'S PERSPECTIVE.
Rupke and Associates Ltd., Bradford (Ontario).
J. W. G. Rupke.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 274-278.

Descriptors: *Aerators, *Aeration, *Wastewater facilities, *Wastewater treatment, Oxygen transfer, Maintenance.

There are a wide variety of mechanical surface aerators available for the pollution control market. They may be fixed mounted or floating, low speed or high speed, rotate in the vertical or horizontal plane, be gear driven, chain driven or belt driven,

have individual drive motors or line shaft driven, with or without draft tubes, and even have lower mixing impellers. There are a number of recurring problems. The inability of surface aerators to transfer the required oxygen capacity, the loss of buoyancy through the accumulation of ice or the water logging of floatation material, and alteration of rotational speed through gearing changes or motor changes may be encountered. Mechanical aerators have several inherent advantages, namely: relatively high oxygenation efficiency, a great deal of operational flexibility, low impact of mechanical failure, and generally can be used in existing shallow tanks. The use of diffused air aeration systems has been common for most of this century in water pollution control plants. There are two basic system types available: course bubble and fine bubble systems. In attempts to improve aeration electrical efficiency a large number of hybrid aeration devices, combining air blower or aspirators with either mechanical mixers or pumps, have been marketed. Some are intended to be operated as surface devices while others are floor mounted subsurface systems. (See also W90-02938) (Mertz-PTT)
W90-02953

OPERATION AND MAINTENANCE/TROUBLESHOOTING.
Ewing Engineering Co., Milwaukee, WI.
D. Redmon.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 279-289. 1 fig, 2 tab, 17 ref.

Descriptors: *Aeration, *Aerators, *Wastewater facilities, *Wastewater treatment, Oxygen transfer, Maintenance, Clogging.

Due to the relatively high oxygen transfer efficiency of fine bubble, ceramic grid equipment, many engineers are considering these systems for retrofits as well as new wastewater treatment facilities. In specifying a ceramic system proper specification of the ceramic element itself is of great importance. Some areas of interest include the desired specific permeability of the element, its wet pressure characteristics and the uniformity of air release across an individual ceramic element. Porous diffuser plants are a popular method of aeration, however, clogging can be a problem. Causes of diffuser clogging on the air side include: dust and dirt from unfiltered air, oil from compressors or viscous air filters, rust and scale from air pipe corrosion, and wastewater solids entering through diffuser or pipe leaks. Diffuser clogging on the liquid side may occur due to fibrous material attached to sharp edges, inorganic fines entering media at low or zero air pressure, organic solids entering media at low or zero air pressure, oils or greases in wastewater, precipitated deposits, and biological growths on diffuser media. (See also W90-02938) (Mertz-PTT)
W90-02954

SELECTED EXPERIENCE WITH AERATORS USED IN THE TREATMENT OF PAPER INDUSTRY WASTEWATERS.
Tufts Univ., Medford, MA.
J. J. McKeown.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 290-298. 2 ref.

Descriptors: *Industrial wastewater, *Aerators, *Wastewater treatment, *Wastewater facilities, *Pulp and paper industry, *Aeration, Oxygen transfer, Activated sludge process, Kraft mills, Pulp wastes.

Operational experience from eight (out of > 400) plants which use aerators in treating paper industry wastewaters is presented. The problems and solutions are representative of those uncovered at other plants employing similar equipment during similar periods of time. No attempt has been made to cover all of the types of aerators in use within the industry or all of the manufacturers which supply the industry with aeration equipment. Further, it is expected that improvements in machin-

ery design, inspection procedures and operational controls provide today's purchasers with a more reliable machine for use in industrial and municipal wastewater treatment systems than may have been the case in the 1970s. Problems were classified as ones largely involving gear wear or failure in systems which fasten the aerator to the tank, basin or air header. Additional problems involving the use of incompatible materials of construction and the failure of motor/shaft seals were occasionally reported. (See also W90-02938) (Mertz-PTT) W90-02955

PROPOSED STANDARD FOR MEASUREMENT OF OXYGEN TRANSFER IN CLEAN WATER.
Michigan Technological Univ., Houghton.
C. R. Baillod, and W. Paulson.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 300-348. 5 tab, 10 ref, 2 append.

Descriptors: *Oxygen transfer, *Design standards, *Oxidation process, *Instrumentation, *Wastewater treatment, *Aeration, *Monitoring, *Dissolved oxygen, *Aerators, Activated sludge process, Wastewater facilities, Statistical analysis, Model studies.

A standard was developed to measure the rate of oxygen transfer from diffused gas and mechanical oxygenation devices to relatively large volumes of water typical of those found in the activated sludge wastewater treatment process. It is intended that this standard be referenced in engineering specifications for compliance testing. The test method is based upon removal of dissolved oxygen from the water volume by sodium sulfite followed by reoxygenation to near the saturation level. The dissolved oxygen inventory of the water volume is monitored during the reaeration period by measuring dissolved oxygen concentration at several points selected so that each point senses an equal tank volume. The method specifies a minimum number, distribution and range of dissolved measurements at each point. The data obtained at each determined point are analyzed by a simplified mass transfer model to estimate the apparent volumetric mass transfer coefficient and the saturation concentration. Nonlinear regression is employed to fit the model to the dissolved oxygen profile measured at each point during reoxygenation. In this way, estimates of volumetric mass transfer coefficient and the saturation concentration are obtained at each point. These estimates are adjusted to standard conditions and the standardized oxygen transfer rate (mass of oxygen dissolved per unit time in clean water under standard conditions of temperature and pressure at an hypothetical concentration of zero dissolved oxygen) is obtained as the product of the average adjusted volumetric mass transfer coefficient value, the average adjusted saturation concentration value and the tank volume. A procedure based on the clean water test results is prescribed for estimation of oxygen transfer rates in dirty water under process conditions. Various components of power consumption are defined and methods for measurement of gas rate and power consumption by the oxygenation device are given. Energy efficiency of the oxygenation device is evaluated as the mass rate of oxygen transferred per unit power consumed. (See also W90-02938) (Author's abstract) W90-02956

OXYGEN TRANSFER TESTING UNDER PROCESS CONDITIONS.
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
H. J. Campbell.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 349-367. 1 fig, 3 tab, 14 ref. EPA Grant EPA-600/2-83-002.

Descriptors: *Monitoring, *Wastewater treatment, *Aeration, *Activated sludge process, *Aerators, *Testing procedures, Evaluation, Oxygen transfer, Tracers, Wastewater facilities.

Aeration testing with respiring activated sludge systems is not easily carried out and is not recommended over clean water aeration testing for verifying aeration performance specifications. However, with careful data collection and evaluation, it is possible to obtain reasonably valid results under process conditions. After review of current testing experience and the inherent errors of each test, the following conclusions are appropriate: Batch endogenous testing procedures are more accurate than continuous testing techniques for estimating field transfer rates of various aeration equipment. The main limitation of continuous testing is the inability to measure the biological oxygen uptake rate accurately. For many applications, specifically for surface aeration installations, the dissolved oxygen concentration may vary spatially within the tank at a given time during testing under continuous loading conditions. For surface aeration equipment, steady state batch endogenous testing is preferable to non-steady state batch endogenous testing. For submerged aeration equipment, non-steady state batch endogenous testing is preferable to steady state batch endogenous testing. Batch endogenous desorption testing using hydrogen peroxide has been demonstrated as an effective technique for measuring field oxygen transfer in surface and submerged aeration systems. The mass balance approach for determining field oxygen transfer rates requires extensive data collection. For activated sludge systems, the approach appears to have value in small, well-mixed systems but is not as accurate as other tests for most systems. The off-gas analysis method for field oxygen transfer measurement has had limited application. The tracer method for field oxygen transfer determination remains relatively untested. Preliminary findings using this technique are encouraging. (See also W90-02938) (Mertz-PTT) W90-02957

AERATOR PERFORMANCE EVALUATION-- THE ONTARIO PERSPECTIVE.
Ontario Ministry of the Environment, Toronto. Pollution Control Branch.
S. A. Black.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 368-378. 2 append.

Descriptors: *Performance evaluation, *Aerators, *Activated sludge process, *Wastewater treatment, *Wastewater facilities, Oxygen transfer, Testing procedures, Ontario, Specifications.

Aeration equipment employed in the activated sludge process is usually the single largest consumer of energy in a wastewater treatment plant. Consequently, the selection of efficient aerators is an essential aspect of treatment plant design. Although oxygen transfer efficiency is only one of several major selection criteria, it has a foremost impact on the long-term energy requirements of plant operations. Acceptance and performance testing procedures adopted by the Ontario Ministry of the Environment in the specification and selection of aeration equipment for activated sludge wastewater treatment facilities in Ontario are discussed. Ontario has adopted a standardized approach including performance evaluation and compliance testing involving a detailed oxygen transfer test procedure. While some criticism may be directed at the conservative nature of the Ministry of the Environment method, it must be realized that all aeration devices receiving Ministry of Environment acceptance are evaluated and rated in a similar manner. (See also W90-02938) (Mertz-PTT) W90-02958

COMPARISON OF DUAL NONSTEADY STATE AND STEADY STATE TESTING OF FINE BUBBLE AERATORS AT WHITTIER NARROWS PLANT, LOS ANGELES.
Manhattan Coll., Bronx, NY. Environmental Engineering and Science Program.
J. A. Mueller.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 380-403. 10 fig, 4 tab, 1 ref, append.

Descriptors: *Oxygen transfer, *Aerators, *Testing procedures, *Aeration, *Wastewater treatment, *Wastewater facilities, Performance evaluation.

The dual non-steady state technique has been developed to evaluate aeration system oxygen transfer coefficients and saturation values under process conditions. The results of applying the technique to a long narrow aeration tank at the Whittier Narrows plant, Los Angeles California are presented. Both the dual nonsteady state and steady state analyses are capable of measuring oxygen transfer coefficients under process conditions in long narrow aeration tanks when constant oxygen uptake rates are obtained. For the Whittier Narrows study, the average non-steady state volumetric transfer coefficient results showed somewhat less variability than the steady state results. In the dual non-steady state analyses, a gas flow ratio of 2:1 provides estimates of oxygen uptake rate and saturation value within +/-12% of steady state uptakes and saturation values estimated from clean water data. This variability is reduced to +/- 5% at a gas flow ratio of 4:1. For the fine bubble diffuser system studied at Whittier Narrows, both non-steady state and steady state results showed that oxygen transfer efficiencies decrease with increasing gas flow per diffuser. (See also W90-02938) (Mertz-PTT) W90-02959

NEW DIRECTIONS IN AERATOR EVALUATION.
Tufts Univ., Medford, MA.
J. S. Hovis, and J. J. McKeown.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 404-413. 22 ref.

Descriptors: *Aerators, *Wastewater treatment, *Wastewater facilities, *Performance evaluation, *Aeration, Oxygen transfer, Tracers, Testing procedures.

Aerators must operate within a system composed of tank dimension and particular mixed liquor characteristics. There is a need to be able to evaluate the performance of the entire system, and to be able to sort out the cause of any inefficiencies which may be found. Two approaches designed to evaluate total system performance in terms of aerator performance involve testing respiring systems. The first is the mass balance approach developed to assist in the evaluation of aerated stabilization basins where other tests are impractical. The approach is inexpensive and uses a mass balance in the oxidation state of the system to arrive at mass transfer. The method has been applied to aerated stabilization systems treating paper industry wastewater and is most suitable for longer detention time systems. The second approach is the inert gas tracer method which has the capability to determine the oxygen transfer in almost any system. The method is applicable to almost any system but may be expensive compared to other methods. The gases used have been radioactive krypton, ethylene and propane. A method which uses stable isotope krypton is currently under development. (See also W90-02938) (Mertz-PTT) W90-02960

NEW DIRECTIONS--OFF GAS METHODS.
Ewing Engineering Co., Milwaukee, WI.
L. Ewing.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 414-433. 1 tab, 2 ref, 3 append.

Descriptors: *Aerators, *Testing procedures, *Wastewater treatment, *Wastewater facilities, Oxygen transfer, Off-gas method, Dissolved oxygen.

The development of testing and procedures for characterization of porous diffusers, development of diffuser specification requirements for improved performance and economy, development of non-process interruptive cleaning procedures for ceramic diffusers, development of equipment to predict the rate of fouling and control fouling, and development and application of gas phase techniques to evaluate the efficiency of diffused aeration equipment or the Off-Gas approach are reviewed. The off-gas equipment appears to be of

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comparable or better accuracy and precision than other dirty water test methods. It is simple and fast and relatively inexpensive, with little process disruption. The off-gas method in the only one which measures performance locally in a tank. It can be used in basins with dissolved oxygen levels of < 0.5 mg/L. The off-gas method can yield useful data to determine alpha and its variability throughout the basin under typical operating conditions. (See also W90-02938) (Mertz-PTT)
W90-02961

FUNDAMENTAL RESEARCH IN BIOLOGICAL WASTEWATER SYSTEMS FOR ADVANCED DESIGN OF MECHANICAL AERATORS.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
F. Nestmann.
IN: Aeration Systems: Design, Testing, Operation and Control. Noyes Publications, Park Ridge, New Jersey. 1986. p 434-440. 4 fig, 2 ref.

Descriptors: *Model studies, *Aerators, *Aeration, *Wastewater treatment, *Wastewater facilities, Performance evaluation, Turbulent flow, Dissolved oxygen, Oxygen transfer, Oxidation process.

At the Institute of Hydromechanics an extensive hydraulic model-system was built for a systematic research effort on mechanical aeration systems sponsored by the German Ministry of Science and Technology. The complexity of the flow and mass transfer process in multiphase systems demanded comprehensive instrumentation. Equipment was chosen to measure the following quantities common to aeration systems: the spatial velocity field and the turbulence distribution, the power input, the characteristics of the mixing time, the local percentage of dissolved oxygen during the unsteady experiment, the local bubble size distribution together with the local gaseous air-content, and the rpm of the 1 kW motor. Analysis of the complete aeration process showed that kinetic energy was necessary to induce convective mass transfer. This energy input created a three-dimensional fully turbulent flow field in the whole basin. In order for the flow to remain fully turbulent it was necessary to overcome the viscous damping by sufficient Reynolds'stresses. Production of turbulence was supported by continuous power input into the system. Otherwise, the turbulence level subsided due to convection, diffusion and dissipation. To optimize an aerator system, detailed research of the flow field is necessary because the turbulent flow structure is the basis for the mass transfer. (See also W90-02938) (Mertz-PTT)
W90-02962

HYDRODYNAMICS AND WATER QUALITY MODELING OF A WET DETENTION POND.
Virginia Univ., Charlottesville. Dept. of Civil Engineering.
D. E. Benelmouffok, and S. L. Yu.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 295-300, 2 fig, 1 tab, 4 ref.

Descriptors: *Water quality, *Monitoring, *Mathematical models, *Hydrodynamics, *Virginia, *Hydrologic models, *Detention reservoirs, *Model studies, *Storm runoff, *Solute transport, Path of pollutants, Nutrients, Nitrogen compounds, Phosphorus compounds, Heavy metals, Shallow water, Mathematical equations, Advection, Dispersion.

A vertically-averaged, two-dimensional hydrodynamic model was developed to simulate the flow and pollutant transport in small-scale basins and to assess the pollutant removal performance of an urban wet detention pond located in Charlottesville, Virginia. The study site was a pond with two inflows (FS1 and FS2) and an outflow (FS3). Three complete storm events were sampled at

these locations for the following pollutants: nitrate, orthophosphate, ammonia, total Kjeldahl nitrogen, total phosphorus, lead, zinc, and total suspended solids. Using the quantity and quality field data from FS1 and FS2 as model inputs, an attempt was made to generate outflow hydrographs and pollutographs for the FS3 outflow. The differential equation were solved numerically on a space-staggered grid using a two-level time alternating direction implicit (ADI) integration scheme. A much better agreement was obtained between the computed and observed values for nitrate, ammonia, and orthophosphate than for the other constituents. Deviations from observed values were higher for total suspended solids, total phosphate, and total Kjeldahl nitrogen. The present results show that a model based on the shallow water equations and a two-dimensional advection-dispersion equation can be applied to analyze flow and pollutant transport in a small basin. (See also W90-02980) (Rochester-PTT)
W90-03022

ADVANTAGE OF HIGH-ORDER BASIS FUNCTIONS FOR MODELING MULTICOMPONENT SORPTION KINETICS.
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
J. A. Pedit, and C. T. Miller.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 293-298, 4 fig, 5 ref. NSF Grant ECE-8503903.

Descriptors: *Model studies, *Wastewater treatment, *Biological wastewater treatment, *Sorption, *Finite element method, *Mathematical models, *Solute transport, Diffusion, Galerkin Method, Numerical analysis, Comparison studies, Algorithms.

The modeling of sorption of competing solutes on solids in a completely-mixed batch reactor was studied. A dual-resistance model is used in which the rate of sorption is described as a series of mass-transfer steps: molecular diffusion through a hydrodynamic boundary layer surrounding a solid particle; and diffusion within the particle itself. The ideal adsorbed solution theory is used to predict multicomponent competitive interactions among the solutes. The Galerkin finite element method is used to solve the spatial derivative describing diffusion is a spherical geometry. A system of ordinary differential equations result that are integrated using Gear's algorithm. The resulting solutions are compared to an analytical solution in the limiting case where mass transfer resistance through the boundary layer is negligible. The main emphasis was the investigation of the effect of using high-order Lagrange polynomials as basis functions. Various order basis functions ranging from first to twelfth order are investigated and the clear advantage of high-order schemes is demonstrated. (See also W90-03036) (Author's abstract)
W90-03078

SOFTWARE PACKAGE FOR THE COMPUTER AIDED DESIGN OF SEWER SYSTEMS.
Vrije Univ., Brussels (Belgium). Lab. of Hydrology.
W. Bauwens.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 439-444, 4 ref.

Descriptors: *Model studies, *Urban hydrology, *Computer programs, *Computer-aided design, *Sewer systems, Design, Graphics, Rational method, Time-area method, Rainfall-runoff relationships, Mathematical models.

A software package is described for the computer-aided design of open sewer networks according to the rational method, the time-area method, and a rainfall-runoff model. Preprocessing and postprocessing are performed under the Graphic Environment Manager (GEM) operating environment. It is coupled to the generalized CAD package ARKEY. The software runs on the Atari ST and is being adapted for use on IBM PC-compatible

microcomputers. The package permits the comparison of sewer design as calculated by different commonly used techniques. (See also W90-03036)(Rochester-PTT)
W90-03100

TREATMENT OF HAZARDOUS WASTE LEACHATE: UNIT OPERATIONS AND COSTS.
PEI Associates, Inc., Cincinnati, OH.
For primary bibliographic entry see Field 5G.
W90-03194

TREATMENT TECHNOLOGIES FOR SOLVENT CONTAINING WASTES.
Alliance Technologies Corp., Bedford, MA.
M. Breton, P. Frillici, S. Palmer, C. Spears, and M. Arienti.
Pollution Technology Review No. 149. Noyes Data Corporation, Park Ridge, New Jersey. 1988. 753p.

Descriptors: *Waste disposal, *Waste recovery, *Sanitary engineering, *Wastewater treatment, *Solvents, Incineration, Biological treatment, Activated carbon, Adsorption, Water reuse, Organic solvents, Waste treatment.

Management options for solvent containing wastes include the treatment and disposal of waste streams as well as waste minimization procedures such as source reduction, reuse, and recycling. Emphasis is placed on proven technologies such as incineration, use as fuel, distillation, steam stripping, biological treatment, and activated carbon adsorption; however, a full range of waste minimization processes and treatment/recovery technologies which can be used to manage solvent wastes is covered in the book. Potentially viable technologies are described in terms of performance in removal of regulated constituents, associated process residuals and emissions, and restrictive waste characteristics which affect the ability of a given technique to effectively treat the wastes under consideration. Approaches to the selection of treatment/recovery options are reviewed, and pertinent properties of organic solvents which impact treatment technology/waste interactions are provided. (Lantz-PTT)
W90-03195

VOLATILIZATION TECHNOLOGIES FOR REMOVING ORGANICS FROM WATER.
IT Corp., Knoxville, TN.
J. L. Fleming.
Pollution Technology Review No. 164. Noyes Data Corporation, Park Ridge, New Jersey. 1989. 120p.

Descriptors: *Wastewater treatment, *Volatilization, *Organic compounds, Performance evaluation, Surface sprayers, Aeration, Bubble columns, Cooling towers, Evaporation, Spray columns, Air stripping.

This guide was written to aid in determining whether a particular volatilization technology can successfully remove organic contaminants from water. It describes the performance evaluation of common volatilization technologies and provides an approach for selecting the appropriate technology for a given situation. Data necessary for the evaluation are described and, whenever possible, background data are given for selected hazardous organics. The volatilization technologies assessed include: surface sprayers, surface aerators, bubble columns, cooling towerrs, steam strippers, unaided evaporation from an impoundment, spray columns, and packed air-stripping columns. The guide enables users to assess performance and cost under a variety of operating conditions (e.g., temperature, influent concentration, allowable liquid and gas effluent concentration, and flow rates) for representative equipment designs that could be transported on a trailer. The designs are used as a basis to calculate representative contaminant removal efficiency, treatment rates, air emissions, and treatment costs of each technology. Qualitative guidance is provided on other factors that should be considered during site-specific assessment of the technical and economic feasibility of volatilization

technologies. Offgas treatment is not described. An example problem is solved to demonstrate the methodology. (Lantz-PTT)
W90-03201

TOXICITY AND ANAEROBIC BIODEGRADABILITY OF SUBSTITUTED PHENOLS UNDER METHANOGENIC CONDITIONS.
New York Univ. Medical Center, NY. Inst. of Environmental Medicine.
O. A. O'Connor, and L. Y. Young.
Environment Toxicology and Chemistry ETOCDK, Vol. 8, No. 10, p 853-862, 1989. 4 fig, 2 tab, 25 ref. DOE Contract DE-AC0284CE and NSF CES 8605143.

Descriptors: *Methanogenesis, *Biological wastewater treatment, *Wastewater treatment, *Biodegradation, *Sludge digestion, *Anaerobic conditions, *Phenols, *Toxicity, Methanol, Organic compounds, Municipal wastes, Mineralization, Bioassay.

Anaerobic biodegradation processes have several advantages over aerobic systems, among them a greater degree of waste stabilization, reduction in volatile solids, and the production of methane (CH4), a clean-burning fuel that results from the anaerobic mineralization of cabonaceous matter. Phenol is the basic structural unit for a variety of synthetic organic compounds and is a transformation product of pesticide dissimilation. Many phenolic derivatives pose very serious health hazards to humans. Phenol, 2-chlorophenol, 2,4-dimethylphenol, 2-nitrophenol, 4-nitrophenol, 2,4-dinitrophenol, 3-methy-4-chlorophenol (4-chloro-m-cresol) and 2-methyl-4,6-dinitrophenol (4,6-dinitro-o-cresol) were evaluated for their anaerobic biodegradability and toxicity to methanogenesis using two anaerobic bioassays, the biochemical methane potential (BMP) and the anaerobic toxicity assay (ATA). The BMP and ATA were used to evaluate the stoichiometric conversion of added substrate carbon to CO2 and CH4. Each substrate was the only added carbon source (20-200 mg/L) prepared in prereduced defined medium using a 10% (v/v) inoculum of municipal digester sludge. All concentrations of phenol and low concentrations (20 mg/L) of 2-chlorophenol, 2-nitrophenol, 4-nitrophenol and 2,4-dinitrophenol were completely mineralized. Higher concentrations (100 mg/L) of these same substrates (100 mg/L) and all concentrations of dimethylphenol, 3-methyl-4-chlorophenol and 2-methyl-4,6-dinitrophenol were observed to undergo no significant mineralization of added substrate and inhibited methanogenesis to varying degrees. Significant biotransformation of the mono-substituted nitrophenols occurred, resulting in the production of the corresponding aminophenols. Acclimation for most compounds took several days to weeks before methane could be detected in the substrate-amended cultures. Generally, the greater the substitution of the phenolic ring, the greater were the recalcitrance and toxicity of the substrate. The fate of these compounds can be significantly influenced by both their concentration and their residence time in anoxic environments. (Author's abstract)
W90-03203

INVESTIGATIONS ON THE EQUIVALENCE OF ANALYTICAL PROCEDURES: DETERMINATION OF CHLORIDE BY FLOW INJECTION ANALYSIS AND DIN-METHOD IN WATER ANALYSIS (UNTERSUCHUNGEN ZUR GLEICHWERTIGKEIT VON ANALYSENVERFAHREN: FLIESSINJEKTIONSANALYSE UND DIN-VERFAHREN BEI DER CHLORIDBESTIMMUNG IN DER WASSERANALYTIK).
Institut fuer Anorganische und Analytische Chemie, Technische Universitaet Berlin, Strasse des 17, juni 135, D-1000 Berlin 12.
For primary bibliographic entry see Field 7B.
W90-03268

ACCUMULATION AND THE EFFECT OF HEAVY METALS ON THE WATER FERN AZOLLA FILICULOIDES.
Hebrew Univ. of Jerusalem (Israel). Dept. of Agricultural Botany.

M. Sela, J. Garty, and E. Tel-Or.
New Phytologist NEPHAV, Vol. 112, No. 1, p 7-12, May 1989. 4 fig, 4 tab, 24 ref.

Descriptors: *Heavy metals, *Bioaccumulation, *Wastewater treatment, *Aquatic plants, *Detoxification, Industrial wastewater, Cadmium, Chromium, Fate of pollutants, Copper, Nickel, Zinc, Chemical analysis, Enzymes.

The majority of methods used to remove heavy metal ions from aqueous media are chemical. However increasing interest in such pollutants has led to investigations of other options, such as the uptake and binding of heavy metals by plants. Azolla filiculoides Lamarck grown for 3-7 days in nutrient media containing 8-15 ppm of different heavy metals was found to contain about 10,000 ppm cadmium, 1990 ppm chromium, 9000 ppm copper, 9000 ppm nickel and 6500 ppm zinc. The content of heavy metal in the roots was two-fold to five-fold higher than in the shoots, and 98% of the heavy metals were bound to the insoluble fraction of the Azolla. The content of heavy metals in dead dried Azolla was 3-7 times higher than in living plants. Zinc and cadmium were more readily transferred from the roots to the shoots than nickel, copper and chromium. Growth in the presence of the heavy metals resulted in severe leakage of K(+), Mg(2+), and Na(+) ions from the roots with less leakage of Ca(2+). The effect of heavy metals on the loss of K(+), Mg(2+), and Na(+) from the shoots was more limited. Nitrogenase activity was almost completely inhibited by cadmium, nickel and zinc, while copper and chromium had less effect. Azolla may prove useful in the detoxification of industrial effluents. (Author's abstract)
W90-03343

EFFECT OF FLUORIDE ON THE SETTLEABILITY OF BIOMASS FROM AN ACTIVATED SLUDGE PLANT TREATING PETROCHEMICAL EFFLUENT.
Indian Petrochemicals Corp. Ltd., Baroda (India).
M. Singh, and D. Kar.
Journal of Fermentation and Bioengineering JFBIEX, Vol. 67 No. 5, p 366-368, May 1989. 2 fig, 2 tab, 10 ref.

Descriptors: *Activated sludge, *Fluorides, *Wastewater treatment, *Oil wastes, Settling velocity, Effluents, Water pollution treatment, Toxicity, Bulking sludge.

In the petrochemical industry, both linear alkyl benzene plants using hydrogen fluoride and petroleum resin plants using boron trifluoride are capable of causing pollution of water by fluorides. Bench scale activated sludge treatment studies were planned to assess the effect of fluoride, added as a pulse or in a continuous manner (50 or 100 mg/L). Growth and chemical oxygen demand (COD) were not significantly affected. Sludge settleability did not change much during pulse feeding, but continuous addition resulted in poor settling. With continuous addition, both the settled sludge volume after 30 min and the sludge volume index showed 100 to 200% increases. Settling characteristics such as high sludge volume index and a clear supernatant, point to sludge bulking as the possible cause of poor settling. (Author's abstract)
W90-03446

ENRICHMENT OF ACETATE-, PROPIONATE-, AND BUTYRATE-DEGRADING CO-CULTURES FROM THE BIOFILM OF AN ANAEROBIC FLUIDIZED BED REACTOR.
Hanover Univ. (Germany, F.R.). Inst. fuer Mikrobiologie.
R. Wollersheim, A. Selz, B. Heppner, and H. Diekmann.
Applied Microbiology and Biotechnology AMBIDG, Vol. 31, No. 4, p 425-429, September 1989. 1 fig, 21 ref.

Descriptors: *Wastewater treatment, *Biodegradation, *Biofilms, *Anaerobic digestion, Fluidized bed process, Bacteria, Acetates, Propionates, Butyrates.

Scanning electron microphotographs from the biofilms of a pilot scale anaerobic fluidized-bed reactor fed with acetate, propionate, and butyrate as carbon sources showed a predominance of filamentous organisms resembling Methanothrix sp. which could be isolated as an almost pure culture as well as a Methanosarcina strain. Three syntrophic cultures, enriched in the medium of Boone and Xun, contained four or five microscopically distinguishable microorganisms, among them Methanospirillum sp., Methanothrix sp., Methanosarcina sp, and rods of acetogenic bacteria degrading propionate or butyrate effectively. (Author's abstract)
W90-03457

PH DEPENDENCE AND EFFECTS OF THE OXIDATIVE PRODUCTS OF SOME AROMATIC COMPOUNDS IN OZONATION UNDER UV IRRADIATION.
East China Inst. of Chemical Technology, Shanghai. Dept. of Environmental Engineering.
S.-C. Xu, H.-D. Zhou, Y. Wei, and J. Lu.
Ozone: Science and Engineering OZSEDS, Vol. 11, No. 3, p 281-296, 1989. 17 fig, 1 tab, 15 ref.

Descriptors: *Wastewater treatment, *Industrial wastes, *Ozonation, *Oxidation, *Ultraviolet radiation, *Aromatic compounds, Hydrogen ion concentration, Nitrotoluene, Methylaniline.

Aromatic compounds (o-nitrotoluene, p-nitrotoluene-2-sulfonic acid, and p-methylaniline-3-sulfonic acid), were ozonized under UV irradiation separately, and the oxidative efficiencies of these reactions were studied. The pH value is an important function in UV-ozonation of many refractory organic substances. In order to ensure continued oxidation, it is advantageous to choose a proper pH value so as to fit the requirements of the chain reaction and also diminish the amount of HO scavengers such as CO3(2-) and HCO3(-) in oxidation products. Removal of carbon dioxide could be effected by acidification of the reaction mixture. In order to decrease the inhibiting effect of the oxidation products, it is advisable to vary the pH value at different stages of UV ozonation, usually the basic range at the initial stage and the acid range at the later stage is advisable. (Author's abstract)
W90-03495

REDUCTIVE DEHALOGENATION AND BIOOXIDATION OF CHLORINATED ETHANES AND METHANES BY ACETOCLASTIC METHANOGENS.
Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences.
S. A. Boyd.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109430/AS, price codes: A03 in paper copy, A01 in microfiche. Final Report, (1989). 43p, 12 fig, 11 tab, 52 ref. USGS Contract 14-08-0001-G1290.

Descriptors: *Chlorinated hydrocarbons, *Dechlorination, *Biotransformation, *Methane bacteria, *Wastewater treatment, Water treatment, Methanosarcina, Haloaliphatic compounds, Biodegradation, Anaerobic environment.

The ability of pure cultures of Methanosarcina to dechlorinate tetrachloroethene (PCE), tetrachloromethane (CT) and bromoform (BF) was established. The dechlorinating bacterium DCB-1 was also shown to dechlorinate PCE. The methanogenic bacteria dechlorinate by a mechanism that is tightly linked to the process of methanogenesis. Over a wide range of primary substrate concentrations (methanol) the CH4-normalized rate of dechlorination remained constant. This rate was much greater (10X) for CF as compared to PCE, thus showing the dechlorination of chloromethanes to be more facile than chloroethenes. The metabolism of 14C-CF by Methanosarcina did not produce 14CH4 but 14CO2 was detected showing that biooxidation was also occurring. These results imply that the activity of acetoclastic methanogens may be ecologically significant in anaerobic habitats contaminated with haloaliphatic compounds. The combined activities of dechlorination, with halaliphatic compounds. The combined activities

of dechlorination, methanogens and methylotrophic bacteria may be useful in the bioremediation of water and aquifer materials contaminated with chlorinated solvents. (USGS)
W90-03554

MANAGEMENT OF SLUDGE FROM PUERTO RICO'S REGIONAL INDUSTRIAL WASTEWATER TREATMENT PLANT: PHASE 2 - DEWATERING.
Puerto Rico Univ., Mayaguez. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5E.
W90-03558

CHEMICAL MODELING OF A DAIRY WASTE/WATER MANAGEMENT, POLLUTION CONTROL SYSTEM FOR FARM MANAGEMENT IN PUERTO RICO.
Puerto Rico Univ., Mayaguez. Dept. of Chemistry.
For primary bibliographic entry see Field 5G.
W90-03559

EFFECT OF TREATED RUM DISTILLERY EFFLUENTS ON THE DISTRIBUTION AND SURVIVAL OF POTENTIAL BACTERIAL PATHOGENS.
Puerto Rico Univ., Rio Piedras. Microbial Ecology Lab.
For primary bibliographic entry see Field 5C.
W90-03560

PLANNING MODEL FOR THE CONTROL AND TREATMENT OF STORMWATER RUNOFF THROUGH DETENTION STORAGE.
Puerto Rico Univ., Mayaguez. Dept. of Civil Engineering.
R. I. Segarra, and G. V. Loganathan.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-107038/AS, price codes: A12 in paper copy, A01 in microfiche. Final Technical Report, Puerto Rico Water Resources Research Institute, Mayaguez, 1989. 287p, 45 fig, 19 tab, 74 ref, append. USGS Contract 14-08-0001-G1041, USGS Project G-1041-03.

Descriptors: *Storage reservoirs, *Storm runoff, *Runoff forecasting, *Runoff rates, *Controlled storage, *Wastewater treatment, Storm water, Model studies, Planning, Water pollution control, Pumped storage, Storage equation, Detention reservoirs, Detention time.

A statistical model has been developed to study the long-term behavior of a stormwater detention unit. This unit stores a portion of the incoming runoff, corresponding to the empty space available in the unit, from which runoff is pumped to a treatment plant. The objective is to avoid, as much as possible, the discharge of untreated runoff to receiving bodies of water. The model was developed by considering the arrival of independent runoff events at the urban catchment. The process variables of event depth, duration, and interevent time were treated as independent, identically distributed random variables. A storage equation was formulated from which the probability of detention unit overflow was obtained. With this distribution it was possible to define the trap efficiency of the unit in terms of the long-term fraction of the runoff volume trapped by the storage unit. The trap efficiency expressions define storage/treatment isoquants, which represent the combinations of storage capacity, treatment rate, and the sewer system runoff trapping capacity, which provide a fixed level of runoff control. A pollutant load model was also formulated, based on a first-order washoff model. This model was used to define pollutant control isoquants. Optimal values of the required storage capacity and treatment rate were obtained by treating the isoquants as production functions. Applying the results of production function theory, a cost minimization problem was solved for the value of the storage capacity and treatment rate, for prescribed runoff and pollutant trap efficiency levels. The results obtained with the statistical model compared well with results obtained from major simulation models. The statistical approach offers an advantage in that no simulation is

required to obtain the isoquants, as the expressions are analytical, thus greatly simplifying the optimization process. Also, the evaluation of the storage unit pollutant trap efficiency can be easily evaluated for any type of pollutant whose washoff rate is unknown. (Segarra-Puerto Rico WRRI)
W90-03561

5E. Ultimate Disposal Of Wastes

EXPERIENCES WITH WASTEWATER-CULTURED DAPHNIA IN THE START-FEEDING OF RAINBOW TROUT (SALMO GAIRDNERI).
Goeteborg Univ. (Sweden). Dept. of Zoophysiology.
G. Dave.
Aquaculture AQCLAL, Vol. 79, No. 1-4, p 337-343, July 1989. 1 fig, 2 tab, 19 ref.

Descriptors: *Wastewater disposal, *Fish farming, *Wastewater, *Trout, *Daphnia, Wastewater utilization, Domestic wastes, Zooplankton.

Daphnia magna was cultured from February to May 1986 in three 1.2 cu m tanks each supplied with domestic sewage from a small plant using activated sludge. The density of Daphnia increased from 30 daphnids/L (biomass from 1.4 to 190 mg/L as dry weight). At the end of March, 90 rainbow trout (Salmo gairdneri) larvae (1.15 grams) were stocked in net pens within the Daphnia tanks. After 56 days, when the experiment was terminated, their survival was 95% and the average growth rate was 4%/day. The tank volume required for continuous production of Daphnia for larval feeding was estimated to be about 1 cu m for 1000 first-feeding rainbow trout larvae (1 L of Daphnia culture/larva). For species with smaller larvae, the volume of Daphnia culture can be reduced accordingly. (Author's abstract)
W90-02653

APPLICATION OF AN INVERSE APPROACH TO A CANADIAN RADIOACTIVE WASTE DISPOSAL SITE.
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W90-02659

INFLUENCE OF PH ON CADMIUM AND ZINC CONCENTRATIONS OF CUCUMBER GROWN IN SEWAGE SLUDGE.
Maryland Univ., College Park. Dept. of Horticulture.
For primary bibliographic entry see Field 5B.
W90-02741

MARINE OUTFALL DESIGN--COMPUTER MODELS FOR INITIAL DILUTION IN A CURRENT.
Memorial Univ. of Newfoundland, St. John's.
For primary bibliographic entry see Field 5B.
W90-02808

WASTEWATER SLUDGE DISPOSAL.
T. M. Radtke, and G. L. Gist.
Journal of Environmental Health JEVHAH, Vol. 52, No. 2, p 102-105, Sep/Oct 1989. 1 fig, 5 tab, 37 ref.

Descriptors: *Sludge disposal, *Pathogenic bacteria, *Antibiotics, Resistance, Plasmid transfer, Land disposal, Klebsiella, Enterobacter.

Bacteria isolated from sludge samples taken from a wastewater treatment plant in upper east Tennessee were tested for antibiotic resistance and R-plasmid transfer. Of the 84 isolated, 61.9% were resistant to at least one of the 11 antibiotics tested, while 46.4% were resistant to two or more antibiotics. The ability to transfer resistance varied from 50% (Klebsiella sp.) to 72.2% (Enterobacter sp.). These results indicate that more study of antibiotic resistant bacteria in wastewater treatment sludge should be considered before sludge is disposed of on land. (Author's abstract)

W90-02820

EFFECT OF SEWAGE-SLUDGE ON THE HEAVY METAL CONTENT OF SOILS AND PLANT TISSUE.
Nova Scotia Agricultural Coll., Truro. Dept. of Chemistry-Soils.
K. S. MacLean, A. R. Robinson, and H. M. MacConnell.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 18, No. 11, p 1303-1316, Nov 1987. 6 tab, 34 ref.

Descriptors: *Sludge utilization, *Soil amendments, *Sludge disposal, *Sludge solids, *Soil analysis, *Heavy metals, *Legumes, *Grasses, Plant tissues, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Zinc.

One of the hazards of sludge application to agricultural land is the accumulation of heavy metals in crops grown on these fields. Domestic sewage sludge applied to farm fields at a rate of 44.9 kg/ha in a mixture with lime and sawdust increased the soil levels of cadmium, chromium, copper, lead, mercury, nickel and zinc. The average levels in sludge treated soil were: 0.11, 0.56, 3.59, 2.72, 0.068, 1.49 and 2.57 ppm, respectively. The increases were small and the overall loading factors were well below recommended maximums. The uptake of these heavy metals by grass and legume plants was variable with cadmium, copper and zinc levels being higher in those plants growing in the sludge treated soils, but only copper was significantly higher. The heavy metal contents found were all within the levels normally found in grass and legume plants. The higher mean concentration in plants growing on the sludge treated soils were cadmium 0.495; chromium 1.22; copper 12.3; lead 1.54; mercury 0.022; nickel 4.08 and zinc 28.4 ppm. Sewage sludge applications in this experiment had a minimal influence on the heavy metal content of the soil and plant tissue tested. (Author's abstract)
W90-02835

IMPACT OF AN EPISODIC EVENT ON THE TOXICITY EVALUATION OF A TREATED MUNICIPAL EFFLUENT.
Procter and Gamble Co., Cincinnati, OH. Environmental Safety Dept.
M. A. Lewis, W. S. Eckhoff, and J. D. Cooney.
Environmental Toxicology and Chemistry ETOCDK, Vol. 8, No. 9, p 825-830, 1989. 1 fig, 2 tab, 23 fig.

Descriptors: *Water quality standards, *Toxicity, *Municipal wastewater, *Wastewater disposal, *Water pollution effects, Fathead minnows, Effluents, Rivers, Pesticides, Metals, Surfactants, Daphnia, Bioassay, Culturing techniques, Ottawa River.

The chronic toxicities of a treated municipal effluent and the corresponding receiving water were evaluated for fathead minnows and Ceriodaphnia dubia in standard 7-d toxicity tests. The effluent and river water were not significantly toxic to the fathead minnow based on measurements for survival and weight. Ceriodaphnia survival after 3 d exposure in the controls and five test concentrations ranged from 60 to 100%, but on test day 4, survival was significantly reduced at all test levels including in the controls. The toxicity was attributable to the dilution water, which was river water collected above the municipal waste water treatment plant outfall. The toxicant(s) in the dilution water was not identified based on a comparison of the daily chemical analyses. Overall, the utilization of the receiving water for dilution water in the toxicity tests showed the potential of an episodic event to control the quality of biota in the receiving water. A second key finding of this study was that the fathead minnow was considerably less sensitive than Ceriodaphnia. Lastly, the yeast/trout food/Cerophyl suspension (YTC) diet-reconstituted water combination used for Ceriodaphnia in this study appears to be nutritionally inadequate. (Author's abstract)
W90-02845

SUPERFUND RECORD OF DECISION: OPERATING INDUSTRIES, CA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-02916

WASTEWATER TREATMENT AND RECEIVING WATER BODY INTERACTIONS.
Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab.
For primary bibliographic entry see Field 5C.
W90-02921

ADJOINT-STATE AND SENSITIVITY COEFFICIENT CALCULATION IN MULTILAYER AQUIFER SYSTEM.
Westinghouse Hanford Co., Richland, WA.
For primary bibliographic entry see Field 2F.
W90-03091

SOFTWARE PACKAGE FOR THE COMPUTER AIDED DESIGN OF SEWER SYSTEMS.
Vrije Univ., Brussels (Belgium). Lab. of Hydrology.
For primary bibliographic entry see Field 5D.
W90-03100

TREATMENT TECHNOLOGIES FOR SOLVENT CONTAINING WASTES.
Alliance Technologies Corp., Bedford, MA.
For primary bibliographic entry see Field 5D.
W90-03195

CULTIVATION OF UPLAND RICE IN DREDGED ESTUARINE LAGOON SPOILS, WITH EMPHASIS ON THE CHEMICAL PROPERTIES OF THE SEDIMENT.
Tohoku Univ., Sendai (Japan). Biological Inst.
Y. Kurihara, and E. Kikuchi.
Journal of Environmental Management JEVMAW, p 115-128, Sep. 1989. 7 fig, 5 tab, 8 ref.

Descriptors: *Spoil disposal, *Dredging, *Sediments, *Chemical properties, *Fate of pollutants, *Estuaries, *Rice, River mouth, Lagoons, Habitat restoration, Sandbars, Odor control, Acidic soils, Sulfides, Nutrients.

The bottom sediments of partially-enclosed lagoons located at the mouth of rivers often show strong reducing conditions due to a high level of microbial activity supported by eroded soil, organic matter and inorganic nutrients. Accordingly, sulfides produced by the reduction of sulfate, which is abundantly present in sea water, form foul-smelling blackish sediment which causes considerable damage to biological resources in estuarine areas. Therefore, restoration of these lagoons is an important environmental problem in Japan today. While dredging is an effective way to remove polluted sediment, finding disposal sites is more difficult. The present study attempted to solve this problem by burying the dredged sediment in a sandbar. This prevents the escape of offensive odors. A second objective was to examine whether the nutrients contained in the dredged materials are sufficient for cultivation of the upland rice plant, Oryza sativa, which tolerates anaerobic and acidic soil conditions. The rice grew well, with a good yield, because salts from the dredged sediments were leached out by rainwater, a plentiful supply of pore water was retained by the smectite, high concentrations of nitrogen and phosphorus were present in the dredged sediments, and the roots of the rice plants had a high tolerance for acidity. (Shidler-PTT)
W90-03234

EFFECT OF WATER TREATMENT SLUDGE ON GROWTH AND ELEMENTAL COMPOSITION OF TOMATO (LYCOPERSICON ESCULENTUM) SHOOTS.
Pennsylvania State Univ., University Park. Dept. of Agricultural Engineering.
H. A. Elliott, and L. M. Singer.
Communications in Soil Science and Plant Analy-

sis CSOSA2, Vol. 19, No. 3, p 345-354, Mar 1988. 4 tab, 10 ref.

Descriptors: *Sludge utilization, *Tomatoes, *Fertilization, *Soil treatment, *Plant growth, Heavy metals, Zinc, Cadmium, Copper, Nickel, Alkalinity, Loam, Silt, Crop yield, Ammonia, Phosphorus.

The impact of a water treatment sludge on the fertility of a silt loam soil was assessed by monitoring the yield and elemental composition of tomato (Lycopersicon esculentum) shoots in a greenhouse study. Application of sludge at rates from 2-10% raised the soil pH from 5.3 to 8.0, which enhanced plant growth. A substantial reduction in metal (Cd, Zn, Cu, Ni) uptake was observed with sludge amendments, even at the highest rates. The alkaline nature of this sludge (pH=9.3, calcium carbonate equivalence=53%) suggests its potential use as a liming material for agricultural soils. Overly alkaline conditions should be avoided however, as high application rates combined with ammonia fertilization had an antagonistic effect on plant growth, possibly from P deficiency induced by struvite (MgNH4PO4) formation. (Author's abstract)
W90-03296

RESIDUAL EFFECTS OF SEWAGE-SLUDGE APPLICATION ON PLANT AND SOIL-PROFILE CHEMICAL COMPOSITION.
Hawaii Univ., Honolulu. Dept. of Agronomy and Soil Sciences.
N. V. Hue.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 19, No. 14, p 1633-1643, Nov 1988. 2 fig, 5 tab, 7 ref.

Descriptors: *Sludge disposal, *Land disposal, *Soil profiles, *Soil chemistry, *Sludge utilization, *Fertilization, *Soil analysis, Plant growth, Sudangrass, Grasses, Sorghum, Heavy metals, Hydrogen ion concentration, Calcium, Phosphorus, Hawaii, Cation exchange.

Long-term effects on plant and soil-profile chemical composition imposed by a residential sewage sludge were studied on an Oxisol from Hawaii. Sludge was applied at 0, 45, 90, and 180 Mg/ha in 1983. An NPK-fertilized treatment was included for comparison. Sudangrass (Sorghum bicolor L. Moench) was grown as a test crop in the 1983-1984 and 1986-1987 seasons. Soil samples for chemical analysis were taken in 1987 at three depths: 0-23 cm, 23-46 cm and 46-69 cm. Beneficial effects of sludge, measured 3 years after application (beginning of the 1986's planting) were evident by large yield increases on sludge-amended soils relative to the unamended and the NPK-fertilized soils. The first cutting produced approximately 5 Mg/ha of dry matter from the sludge treatments, regardless of rate, as compared with 3 and 1.5 Mg/ha from the NPK and the 0 treatments. Regrowths showed similar effect, though less dramatic; average yields were 2.6 Mg/ha with sludge and 1.6 Mg/ha without. Heavy-metal concentrations in plants were generally unaffected by sludge applications; probably because (i) heavy-metal contents of the sludge were low, and (ii) soil pH was increased by sludge. Remarkable increases in pH, exchangeable Ca and extractable P, and resultant decreases in exchangeable Al, in all three soil layers of sludge-amended soils suggest that surface application of a low heavy-metal sludge could serve to correct subsoil acidity and enhance subsoil P availability. (Author's abstract)
W90-03298

FACTORS AFFECTING ZINC CONCENTRATIONS IN PLANTS GROWN IN SLUDGE-AMENDED SOILS.
Massachusetts Univ., Amherst. Dept. of Plant and Soil Sciences.
For primary bibliographic entry see Field 5B.
W90-03301

SULPHUR TRANSFORMATION AFFECTED BY THE APPLICATION OF WASTEWATER FROM OLIVE PROCESSING ON SOIL.
Estacion Experimental del Zaidin, Granada

(Spain). Dept. de Quimica Agricola.
J. D. Perez, and G. Gallardo-Lara.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 20, No. 1-2, p 75-84, Jan 1989. 2 fig, 18 ref. C.S.I.C. Project No. ID-286.

Descriptors: *Wastewater disposal, *Industrial wastes, *Food-processing wastes, *Land disposal, *Sulfur, *Soil chemistry, *Calcareous soils, Wastewater, Soil analysis, Vegetation wastewater, Acidity, Fertilizers, Incubation, Sulfates.

Vegetation water is the term used to describe the residual water produced during the industrial extraction of olive oil. This material is characterized by its high organic matter content and moderately acidic pH. Disposal of vegetation water poses serious problems for the oil-producing industries. The use of vegetation water as fertilizer has been suggested as a possible solution to this problem, given its organic matter and potassium content. Recently in an incubation experiment, the effects of the application of wastewater from olive processing on soil nitrogen transformation was studied. There are, however, no references in the literature as to what effect vegetation water may have on sulfur transformation in soil. An incubation experiment was performed to study the effects of vegetation water on S transformation in a calcareous soil. In addition to raw vegetation water, other preparations were tested including vegetation water devoid of organic matter and deionized vegetation water. The addition of olive wastewater to soil inhibits the formation of $S-SO4(-2)$ when vegetation water plus elemental S is compared to a treatment consisting of elemental S applied alone. No such effect, however, was seen when the treatment with vegetation water only is compared with control soils. Of the three types of vegetation water tested, the least effective inhibitor of $S-SO4(-2)$ formation was the wastewater in which all organic matter had been eliminated, while the deionized effluent yielded lowest levels of $S-SO4(-2)$. The exclusive application of vegetation water on calcareous soils may raise $S-SO4(-2)$ levels in the middle run; however, when an S deficient soil is fertilized with elemental S, concurrent application of vegetation water is unadvisable, given that it may interfere with soil $S-SO4(-2)$ formation. (Mertz-PTT)
W90-03303

ZINC, COPPER, AND NICKEL AVAILABILITIES AS DETERMINED BY SOIL SOLUTION AND DTPA EXTRACTION OF A SLUDGE-AMENDED SOIL.
Kansas State Univ., Manhattan. Dept. of Agronomy.
J. F. Adams, and D. E. Kissel.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 20, No. 1-2, p 139-158, Jan 1989. 1 fig, 4 tab, 35 ref.

Descriptors: *Bioavailability, *Soil solution, *Sludge disposal, *Soil amendments, *Sludge utilization, *Land disposal, *Sludge, *Chemical analysis, *Soil analysis, *Heavy metals, *Soybeans, Hydrogen ion concentration, Zinc, Copper, Nickel, DTPA, Plant growth, Chelation.

Extracting sludge-amended soil with diethylenetriamine pentaacetic acid (DTPA) does not always give a reliable measure of plant-available heavy metals. The major purpose of this greenhouse pot study was to help explain why. Two anaerobically digested sludges from sewages treated with either Ca(OH)2 or FeCl3 were applied to 3-kg samples of a Mollic Albaqualf previously limed with Ca(OH)2 rates of 2, 2.5, and 10 g/pot that resulted in pHs in the check pots of 5.4, 6.2, or 7.7 after the first harvest. Sludge rates provided 0, 200, 400, 800, and 1600 mg Zn/kg of soil. Two consecutive crops of soybeans (Glycine max L.) were grown for 42 days each in the greenhouse. DTPA-extractable, soil-solution, and plant concentrations of Cu(2+), Ni(2+), and Zn(2+) were measured. Dry matter yields were depressed due to salt toxicity, while DTPA-extractable Cu(2+) correlated with plant uptake of Cu(2+) for both sludges. DTPA-extracted Ni(2+) did not correlate with plant uptake of Ni(2+) from the Ca(OH)2-sludge-amended soil,

although DTPA-extracted Ni(2+) did not correlate with plant uptake of Ni(2+) from the FeCl3-sludge-amended soil, DTPA-extracted Zn did not correlate with plant uptake of Zn(2+) from any sludge-amended soil. Soil-solution composition correlated with plant uptake of Cu(2+) and Ni(2+) in both sludges; it also correlated with plant uptake of Zn(2+) form FeCl3-sludge-amended soil but not from Ca(OH)2-sludge-amended soil. DTPA extraction probably failed with Ni(2+) and Zn(2+) because of (i) its ineffectiveness at low pH, (ii) the inability of DTPA to buffer each soil extract near pH 7.3, and (iii) increased amounts of soluble chelated micronutrients at higher sludge rates and higher soil pHs. Soil-solution composition seemed to fail only where micronutrient cations in solution probably were present largely as organic chelates. (Author's abstract)
W90-03304

GROWTH RESPONSE AND MINERAL UPTAKE OF VEGETABLE TRANSPLANTS GROWN IN A COMPOSTED SEWAGE SLUDGE AMENDED MEDIUM. I. NUTRIENT SUPPLYING POWER OF THE MEDIUM.
Maryland Univ., College Park. Dept. of Horticulture.
A. Falahi-Ardakani, J. C. Bouwkamp, F. R. Gouin, and R. L. Chaney.
Journal of Environmental Horticulture JEHOD5, Vol. 5, No. 3, p 107-111, Sep 1987. 4 fig, 13 ref.

Descriptors: *Nutrients, *Vegetable crops, *Composting, *Soil amendments, *Sludge utilization, *Growth media, *Plant growth, *Minerals, Broccoli, Cabbage, Lettuce, Eggplant, Tomatoes, Phosphorus, Calcium, Magnesium, Nitrogen, Potassium, Pepper plants, Perlite, Peat.

Six vegetable species, broccoli, cabbage, lettuce, eggplant, pepper, and tomato plants were grown for 8 weeks on a medium of composted sewage sludge (compost), perlite, and peat (equal parts by volume). P, Ca, and Mg were adequate for the growing period, but accumulation of N and K did not increase after the 6th week after transplanting. Cabbage and broccoli accumulated greater amounts of N and K from the medium and could be successfully grown in the medium without supplemental fertilization. Zn and Cd, potentially hazardous heavy metals present in compost, did not reach excessive levels for either plant nutrition or human consumption. (See also W90-03312 and W90-03313) (Author's abstract)
W90-03311

GROWTH RESPONSE AND MINERAL UPTAKE OF VEGETABLE TRANSPLANTS GROWING IN COMPOSTED SEWAGE SLUDGE AMENDED MEDIUM. II. INFLUENCED BY TIME OF APPLICATION OF N AND K.
Maryland Univ., College Park. Dept. of Horticulture.
A. Falahi-Ardakani, F. R. Gouin, J. C. Bouwkamp, and R. L. Chaney.
Journal of Environmental Horticulture JEHOD5, Vol. 5, No. 3, p 112-115, Sep 1987. 3 fig, 3 tab, 5 ref.

Descriptors: *Plant growth, *Vegetable crops, *Composting, *Soil amendments, *Fertilization, *Sludge utilization, *Growth media, *Nitrogen, *Potassium, *Minerals, Broccoli, Cabbage, Eggplant, Tomatoes, Lettuce, Phosphorus, Calcium, Magnesium, Manganese, Zinc, Iron, Pepper plants, Peat, Perlite, Tissue analysis, Plant tissues.

Six species of vegetable transplants were grown in market packs filled with peat moss, perlite and screened sewage sludge compost (equal parts by volume). Compost was made from lime-dewatered sludge and woodchips. Seedlings were fertilized at 1, 2, 3, and 4 weeks after transplanting in single, split and multiple applications of varying levels of N and K in factorial combinations. Fertilizer application could be delayed 1 to 2 weeks after transplanting without a loss of top growth. Lettuce, broccoli and cabbage plants were grown to marketable size with only N fertilizer. However, eggplants, tomato and petter plants grew best when

fertilized with both N and K. Acceptable levels of P, Ca, Mg, Mn, Zn and Fe, as measured in tissues, were provided by the growth medium and tissue Cd levels were within acceptable limits. (See also W90-03311 and W90-03313) (Author's abstract)
W90-03312

GROWTH RESPONSE AND MINERAL UPTAKE OF LETTUCE AND TOMATO TRANSPLANTS GROWN IN MEDIA AMENDED WITH COMPOSTED SEWAGE SLUDGE.
Maryland Univ., College Park. Dept. of Horticulture.
A. Falahi-Ardakani, J. C. Bouwkamp, F. R. Gouin, and R. L. Chaney.
Journal of Environmental Horticulture JEHOD5, Vol. 6, No. 4, p 130-132, Dec 1988. 3 tab, 9 ref.

Descriptors: *Composting, *Soil amendments, *Growth media, *Sludge utilization, *Lettuce, *Tomatoes, *Plant growth, *Minerals, Zinc, Cadmium, Lead, Nickel, Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Manganese, Heavy metals.

Lettuce (Lactuca sativa L., Summer Bibb) and tomato (Lycopersicon esculentum Mill., Westover) were grown 4 weeks in plastic market packs in 3 experimental media and a commercially available (Maryland Mix) control. The experimental media were prepared by combining equal parts, by volume of: (1) screened composted sewage sludge (made from lime dewatered ferric chloride treated sewage sludge and wood chips), peat moss, and perlite; (2) composted sewage sludge, peat moss, and vermiculite ; and (3) composted sewage sludge, perlite, and vermiculite. A commercially prepared medium, Maryland Mix consisting of silt loam, peat, perlite, and vermiculite (1:2:1:1 by vol) was used as a control. The market packs containing 6 transplants each, were arranged in a completely randomized design and replicated 4 times. One set of seedlings were grown in Maryland Mix and composted sewage sludge, peat moss and perlite and fertilized at the end of the 1st, 2nd, and 3rd week after transplanting with a commercial 20N-8.6P-16.6K (20-20-20) fertilizer. Another set of seedlings were grown for 4 weeks in the control mix and 3 experimental media and fertilized at weeks 1 and 3 after transplanting with only N fertilizer. For both lettuce and tomato plants, only 270 mg of N per market pack per growing period produced marketable size transplants when grown in the composted sewage sludge, peat moss, vermiculite medium. These seedlings had no toxic levels of Zn, Cd, Pb, and Ni and contained adequate N, P, K, Ca, Mg, Mn, Fe, and Cu as compared to plants grown in the control medium. (See also W90-03311 and W90-03312) (Author's abstract)
W90-03313

SILVICULTURAL USE OF WASTEWATER SLUDGE.
Michigan State Univ., East Lansing. Dept. of Forestry.
J. B. Hart, P. V. Nguyen, D. H. Urie, and D. G. Brockway.
Journal of Forestry JFUSAI, Vol. 86, No. 8, p 17-24, Aug 1988. 6 fig, 2 tab, 25 ref. EPA Assistance Agreement SOO5551.

Descriptors: *Waste disposal, *Land disposal, *Wastewater farming, *Sludge utilization, *Forest management, *Mixed forests, *Fertilization, *Michigan, Evaluation, Land management, Environmental effects, Cycling nutrients, Plant growth, Wildlife habitats.

Applying wastewater sludge to forestland represents an important land-management opportunity that also addresses an environmental need. An operational-scale forestland application study examined the silvicultural, hydrologic, wildlife, social, logistic, and economic aspects of sludge fertilization. Ten-year-old aspen copice and 50 to 70-year-old northern hardwoods, mixed oak, and red pine-jack pine stands of 40 acres were selected on state forestland in northern Michigan's Montmorency County. Treatments in each stand, replicated three times and randomly assigned to indi-

vidual 3.8-acre plots, consisted of control, application trails only, and sludge application from trails. Sludge-applied nutrients substantially enhanced nutrient cycling, tree growth, wildlife habitat, and nutritional quality of forage plants in the forest. At appropriate application rates, these benefits were obtained while avoiding groundwater contamination and toxicant transmission in the food chain. Forestland application methods were shown to be technologically feasible and cost effective. (Mertz-PTT)
W90-03315

SURFACE THERMAL PLUME IN CHANNEL.
University of Western Ontario, London. Faculty of Engineering Science.
For primary bibliographic entry see Field 5B.
W90-03330

NOTE ON AYOUB'S DATA OF HORIZONTAL ROUND BUOYANT JET IN CURRENT.
Hong Kong Univ. Dept. of Civil and Structural Engineering.
J. H. W. Lee.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 7, p 969-975, July 1989. 4 fig, 9 ref.

Descriptors: *Jets, *Wastewater disposal, *Mixing, *Flow characteristics, Data interpretation, Hydraulics, Rivers, Estuaries.

For the buoyant jet-in-crossflow problem, there have been only a few investigations in which both the jet trajectory and tracer concentration are measured. In particular, there is insufficient dilution data in the far field of a momentum-dominated buoyant jet in a crossflow. The prediction of jet dilution in the momentum-dominated far field (MDFF) is intimately related to the discharge of wastewater into rivers or brackish estuarine waters of small salinity (for example, at times of large freshwater flows during the wet season). A comprehensive investigation which has not received much attention was undertaken by Ayoub in 1971. Both concentration and trajectory were measured for a horizontal momentum-dominated buoyant jet in a crossflow, with a three-dimensional trajectory. Ayoub's data is re-interpreted to give trajectory and centerline dilution relations in the MDFF and centerline dilution of a horizontal jet in a coflowing current. These data correlate well with equations for jet trajectory and dilution obtained by dimensional analysis. In previous analyses of vertical jet data, the vertical position of the centerline dilution (the minimum dilution in either a normal or vertical traverse in the plane of symmetry) was used in the dilution correlation; the dilution constants so obtained for the MDFF and BDFF (the far field of a buoyancy dominated discharge) are both around 0.4. The present analogous interpretation of Ayoub's data appears to suggest a smaller rate of mixing in the MDFF. (Ence-PTT)
W90-03336

NUTRITION AND YIELD OF YOUNG APPLE TREES IRRIGATED WITH MUNICIPAL WASTE WATER.
Agriculture Canada, Summerland (British Columbia). Research Station.
For primary bibliographic entry see Field 3F.
W90-03364

FAECAL COLIFORM DECLINE ON PASTURE IRRIGATED WITH PRIMARY TREATED MEAT-PROCESSING EFFLUENT.
Meat Industry Research Inst. of New Zealand, Hamilton.
M. Donnison, and R. N. Cooper.
New Zealand Journal of Agricultural Research NEZFA7, Vol. 32, No. 1, p 105-112, 1989. 3 fig, 2 tab, 36 ref.

Descriptors: *Wastewater irrigation, *Wastewater disposal, *Pastures, *Food-processing wastes, *Coliforms, Most probable number method.

Meat-processing effluent was applied to pasture every 14 days at a rate equivalent to 1000 kg N/ha/year. Fecal coliforms on pasture, as indicator organisms, were enumerated by a Most Probable Number method over a 12-month period. Regression of fecal coliform counts against time demonstrated a decline in numbers, which followed first-order kinetics over the 14-day period after an irrigation. Reduction in counts was not well correlated with environmental factors. A 99% reduction in numbers occurred after 14 days in all seasons of the year, with a 99.9% reduction in winter and spring. Rates of decline were highest in spring and lowest in summer. (Author's abstract)
W90-03375

USE OF SEWAGE SLUDGE AS SOIL AMENDMENT: EFFECT ON YIELD OF FORAGE AND SOIL CHEMICAL PROPERTIES.
Puerto Rico Univ., Mayaguez. Dept. of Agronomy and Soils.
J. Villarrubia, and N. Cavallaro.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109422/AS, price codes: A03 in paper copy, A01 in microfiche. Final Technical Report, Puerto Rico Water Resources Research Institute, Mayaguez, August 1987. 32p, 11 tab, 41 ref.

Descriptors: *Puerto Rico, *Wastewater irrigation, *Sludge utilization, *Sludge disposal, *Soil amendments, *Soil chemistry, *Soil properties, Forages, Crop yield, Ultisol soil, Metals, Phosphorus, Calcium, Cation exchange, Hydrogen ion concentration, Municipal wastewater.

A field experiment was carried out to evaluate the effect of municipal sewage sludge on forage yield and quality and on soil chemical properties and extractable metals. Sludge was applied to a very acid Ultisol soil in Mayaguez, Puerto Rico, corn and sorghum were planted, and dry matter yield was determined. Sludge and tissue samples were analyzed for nutrient and heavy metal content. Soil samples, taken three times throughout the season, were analyzed for exchange properties, pH and available nutrients. Yield with sludge equaled or surpassed the recommended complete fertilizer treatment. No significant increase in heavy metal content of the forage was seen, but phosphorus and calcium content was increased by the sludge. Available phosphorus, exchangeable calcium, cation exchange capacity, and pH were increased while exchangeable acidity was decreased by sludge applications. (Villarrubia-Puerto Rico, WRRI)
W90-03547

MANAGEMENT OF SLUDGE FROM PUERTO RICO'S REGIONAL INDUSTRIAL WASTEWATER TREATMENT PLANT: PHASE 2 - DEWATERING.
Puerto Rico Univ., Mayaguez. Dept. of Chemical Engineering.
A. Rodriguez, and J. Benitez.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109406/AS, price codes: A05 in paper copy, A01 in microfiche. Final Technical Report, Puerto Rico Water Resources Research Institute, Mayaguez, Sept 1988. 88p, 12 fig, 2 tab, 29 ref, 7 append. USGS Contract 13-08-0001-G-1041. USGS Project G-1041-05.

Descriptors: *Sludge digestion, *Vacuum filter, *Sludge drying, *Dewatering, *Sludge disposal, *Industrial wastewater, Wastewater facilities, Puerto Rico, Coagulation.

The most important variables influencing the performance of vacuum filters were studied for the particular case of dewatering the primary and digested sludges from the Barceloneta Regional Wastewater Treatment Plant. Jar tests were performed to determine the optimum coagulant requirements for both types of sludge. Buchner funnel tests were used to measure their specific resistances at an applied vacuum of fifteen inches of mercury. The specific resistance for the digested sludge was found to be significantly higher than for the primary sludge. A model was developed,

based on Darcy's law, to correlate the loading to a vacuum filter with operational parameters such as applied pressure, solids deposited/unit volume of filtrate, and form time. Other parameters included in the model were the viscosity of the filtrate and the specific resistance of the sludge. Experimental data were obtained through filter leaf tests to evaluate the empirical parameters of the model. The experimental results were correlated using a non-linear multiple regression program. A statistical analysis of the regression results led to the conclusion that the model developed was a satisfactory representation of the behavior of a vacuum filter and, therefore, could be used for the design of a full-scale facility for the dewatering of the sludges from the Barceloneta Regional Treatment Plant. Some preliminary results were obtained on dewatering primary and digested sludge using a batch centrifuge. Primary sludge seemed to be easier to dewater by this method than digested sludge. (Rodriguez-Puerto Rico WRRI)
W90-03558

5F. Water Treatment and Quality Alteration

EFFECTS OF BOREHOLE WELLS ON WATER UTILIZATION IN SCHISTOSOMA HAEMATOBIUM ENDEMIC COMMUNITIES IN COAST PROVINCE, KENYA.
Cornell Univ., Ithaca, NY.
H. El Kholy, T. K. Arap Siongok, D. Koech, R. F. Sturrock, and H. Houser.
American Journal of Tropical Medicine and Hygiene AJTHAB, Vol. 41, No. 2, p 212-219, August 1989. 1 fig, 4 tab, 15 ref.

Descriptors: *Well water, *Public health, *Developing countries, *Boreholes, *Parasites, *Surveys, Water use, Drinking water, Schistosomiasis, Wells, Snails, Kenya.

To determine the impact of the introduction of borehole wells on water use patterns and the consequent risk of transmission of Schistosoma haematobium in 3 endemic villages in Kenya, a survey (a 1:6 sample of affected households) was conducted to identify sources of water and types of water utilization before and after well introduction. Water usage was also determined in two unaffected neighboring villages not given borehole wells, but having continuous access to piped water from communal taps. Prior to borehole well construction, significantly more high-risk water use occurred in the borehole villages vs. comparison villages in terms of water gathered for cooking, drinking, dish washing, and bathing; residents of both types of villages preferred high-risk sources (marhses and ponds) for clothes washing. Following well introduction, there were significant declines in the use of high-risk water for drinking, cooking, and dish washing, but not for bathing or clothes washing. A higher proportion of individuals from the three borehole villages reported some type of continued contact with high-risk water sources. Despite well introduction and a 3 year chemotherapy program among school-aged children, a 21-28% incidence of infection persisted among children in the villages, suggesting minimal impact on transmission. Regular monitoring for S. haematobium infected snail sites showed no decline in the number or proportion of infected snails. Borehole well introduction can significantly alter some forms of water usage, but social and water quality factors may limit the ability of communal wells to reduce S. haematobium transmission. (Author's abstract)
W90-02652

BIOLOGICAL DENITRIFICATION OF WATER.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
B. P. Gayle, G. D. Boardman, J. H. Sherrard, and R. E. Benoit.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 115, No. 5, p 930-943, October 1989. 60 ref.

Descriptors: *Water treatment, *Denitrification, *Drinking water, *Foreign research, *Literature review, Substrates, Unit processes, Commercial facilities, Nitrites, Process control, Research priorities.

Most of the voluminous research that has been published regarding the denitrification of drinking water has been done in Europe. Unfortunately, much of this literature has not been translated into English, and as a consequence there may be a gap in the understanding of the international state of the art with regard to drinking-water denitrification. Numerous substrates have been evaluated including methanol, ethanol, acetic acid, methane, carbon monoxide, hydrogen, and various sulfur compounds. Various unit processes have been utilized including biofilters, fluidized-bed and packed-bed reactors, packed towers containing cells immobilized in polymer gels, and completely mixed reactors with cells attached to bouyant porous carriers. There are several commercial facilities currently providing drinking water to European communities. Most include post-treatment with flocculation, filtration, and disinfection. A common concern in denitrification operations is the minimization of nitrite accumulation. This requires careful process control, and more research regarding the nitrite problem is needed. The European literature is a valuable source of information regarding the denitrification of drinking water. (Author's abstract)
W90-02718

INACTIVATION OF GERBIL-CULTURED GIARDIA LAMBLIA CYSTS BY FREE CHLORINE.
Ohio State Univ., Columbus. Water Resources Center.
A. J. Rubin, D. P. Evers, C. M. Eyman, and E. L. Jarroll.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 10, p 2592-2594, 1989. 3 fig, 1 tab, 15 ref. EPA Agreement CR812238-01-1.

Descriptors: *Chlorination, *Giardia, *Disinfection, Public health, Gerbils, Cysts, Contact time, Free chlorine.

Giardia lamblia cysts were harvested from Mongolian gerbils and exposed to free chlorine in buffered water at pH 5, 7, and 9 at 15 degrees C. The contact times required to obtain a 2-log reduction in cyst survival (i.e., a 99% kill) were interpolated from survival curves generated at fixed concentrations of chlorine in the range of 0.25 to about 16 mg/L. Concentration-time (C/t) products for 99% inactivation ranged from about 120 to nearly 1,500 mg/min/L. These values are higher than those reported previously for free chlorine using G. lamblia cysts from infected humans. The cysts isolated from gerbils, as with other Giardia cysts, were unusually sensitive to chlorine in alkaline solutions. (Author's abstract)
W90-02793

CHILDHOOD LEAD POISONING.
Massachusetts Dept. of Public Health, Boston. Childhood Lead Poisoning Prevention Program.
E. Cosgrove, M. J. Brown, P. Madigan, P. McNulty, and L. Okonski.
Journal of Environmental Health, JEVHAH, Vol. 52, No. 1, p 346-349, Jul/Aug 1989. 1 fig, 5 tab, 42 ref.

Descriptors: *Water quality control, *Lead, *Drinking water, *Public health, Water transport, Pipes, Toxicity, Regulations, Economic aspects.

Lead poisoning as a result of drinking water carried through lead service lines has been well-documented in the literature. A case of childhood lead poisoning is presented in which the only identified source of lead was lead solder from newly installed water pipes. Partly as a result of this case, the Massachusetts Board of Plumbers and Gas Fitters banned the use of 50/50 lead-tin solder on potable water lines. It is anticipated that this ban will increase the cost of new housing by only $16 per

unit but will significantly reduce one environmental source of lead. (Author's abstract)
W90-02818

CROSS CONNECTION CONTROL.
S. R. Anderson.
Journal of Environmental Health JEVHAH, Vol. 52, No. 1, p 341-344, Jul/Aug 1989. 4 fig, 1 tab, 4 ref.

Descriptors: *Potable water, *Water conveyance, *Public health, Cross connections, Backflow, Contamination, Ordinances, Inspection.

Inspections of potable water supply systems and the investigation of related complaints have shown the need for continued surveillance to ensure that appropriate backflow protection is provided where needed. Research and survey work conducted in San Mateo County, California, since 1984, indicates a number of health risks among a variety of establishment types: submerged inlets were found to be the cause of a water contamination incident; a high degree of hazard may exist at facilities having auxiliary water supplies or where chemicals are used; and plumbing work by personnel without an understanding of cross connection control principles can lead to the direct contamination of a water supply. The basic components of an effective cross connection control program include: (1) a law or ordinance making cross connections illegal; (2) an inspection program; (3) a method of eliminating cross connection hazards by providing air gaps or selecting appropriate backflow protective devices to be installed; and (4) public education. (Author's abstract)
W90-02819

SUPERFUND RECORD OF DECISION: CHEROKEE COUNTY/GALENA, KS.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-02920

IMPACT OF GROUNDWATER CONTAMINATION OF PUBLIC WATER SUPPLIES.
Montgomery (James M.), Inc., Gainesville, FL.
J. E. Singley.
Florida Scientist FLSCAQ, Vol. 52, No. 4, p 240-243, Oct 1989. 4 tab, 5 ref.

Descriptors: *Water pollution effects, *Water supply, *Water treatment, *Groundwater pollution, *Drinking water, *Potable water, *Carcinogens, *Organic compounds, Water pollution, Water analysis, Cleanup, Economic aspects, Environmental protection, Public health, Benzenes, Polychlorinated biphenyls, Heptachlor, Aromatic compounds, Water treatment facilities, Water costs.

The presence of a wide variety of organic contaminants in groundwater has required that additional treatment processes be added to the present treatment train in potable water treatment plants. Among the many contaminants identified, the most concern has been focused on the synthetic organic compounds. The Environmental Protection Agency's (EPA's) Carcinogen Assessment Group has identified 19 carcinogens. The Safe Drinking Water Act requires that these be regulated. Of the nineteen, trihalomethanes, heptachlor epoxide and heptachlor, vinyl chloride, and carbon tetrachloride present the greatest cancer risk (322, 42, 40, and 12 cases per year, respectively). Florida established regulations for control of 8 volatile organic contaminants and requires monitoring of each well for 118 additional synthetic organic compounds in order to build a database on such contaminants. The EPA has established maximum contaminant level goals for 34 organic contaminants. One immediate impact upon all public water supplies is the expense of the analyses required. This has been estimated to be from $1,000 to $1,500 per well. Treatment can easily double the cost of water to the consumer under conditions where severe contamination has occurred. In those cases where one of the volatile organics is present, the cost of treatment may increase by $0.05 to $0.10 per thou-

sand gallons. The average cost of water to the customer is approximately $1.25 per thousand gallons. Treatment technology has advanced to the point that any contaminant can be removed but the cost varies dramatically. The American public has said that it is willing to pay more for better water and it will soon have to do so. (Ence-PTT)
W90-03217

OPTIMIZATION MODEL FOR WATER DISTRIBUTION SYSTEM DESIGN.
Oklahoma State Univ., Stillwater. School of Civil Engineering.
K. E. Lansey, and L. W. Mays.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 10, p 1401-1418, Oct 1989. 6 fig, 3 tab, 19 ref. NSF Grant ECE-8511394.

Descriptors: *Hydraulic design, *Hydraulic models, *Water distribution, *Computer models, *Simulation analysis, Optimization, Conveyance structures, Pipelines, Pumps, Pumping plants, Water tanks, Control systems.

A new methodology is developed for determining the optimal (minimum-cost) design of water distribution systems. The components that can be sized are the pipe network, pumps or pump station, and tanks. In addition, the optimal settings for control and pressure-reducing valves can be determined. This methodology couples nonlinear programming techniques with existing water distribution simulation models. Previous methodologies have typically simplified the system hydraulics to be able to solve the optimization problem. The new methodology retains the generality of the hydraulic simulation model so that the problem is only limited by the ability of the simulation model rather than the optimization model. The methodology uses a generalized reduced gradient model to solve a problem that is reduced in size and complexity by implicitly solving the conservation of mass and energy equations using the hydraulic simulator and an augmented Lagrangian approach to incorporate pressure head bounds in the objective function. Since the network equations are solved implicitly any number of demand patterns can be considered, including steady state loads, extended period simulations, or both. (Author's abstract)
W90-03224

INVESTIGATIONS ON THE EQUIVALENCE OF ANALYTICAL PROCEDURES: DETERMINATION OF CHLORIDE BY FLOW INJECTION ANALYSIS AND DIN-METHOD IN WATER ANALYSIS (UNTERSUCHUNGEN ZUR GLEICHWERTIGKEIT VON ANALYSENVERFAHREN: FLIESSINJEKTIONSANALYSE UND DIN-VERFAHREN BEI DER CHLORIDBESTIMMUNG IN DER WASSERANALYTIK).
Institut fuer Anorganische und Analytische Chemie, Technische Universitaet Berlin, Strasse des 17, juni 135, D-1000 Berlin 12.
For primary bibliographic entry see Field 7B.
W90-03268

PIPE JOINT RESTRAINTS.
S E A Consultants, Inc., Cambridge, MA.
For primary bibliographic entry see Field 8A.
W90-03402

CONTROLLED ENVIRONMENT VAULTS FOR WATER DISTRIBUTION SYSTEMS.
Engineered Fluid, Inc., Centralia, IL.
J. E. Kruzic.
Journal of the New England Water Works Association JNEWA6, Vol. 103, No. 3, p 144-147, November 1989. 2 fig, 1 tab.

Descriptors: *Water conveyance, *Conveyance structures, *Pipelines, *Underground structures, Construction costs, Operating costs, Steel.

Underground vaults have always been used to house pumps, valves, and meters in water pipelines. In the past, the only choices for vault material were brick and concrete, and these structures were designed with the understanding that they would be damp and wet. However, the equipment

housed in underground vaults is becoming more sophisticated, so that it is desirable to use a factory built and tested controlled environment vault (CEV) to house old workhorse components as well as the new electronic and monitoring equipment. The CEV provides a heated, dehumidified atmosphere in a big, roomy steel vault. The structure is watertight to keep equipment including telemetry clean and dry. The vault is well lit and provides an atmosphere conducive to maintenance. Standard components are power panel, sump pump, heater, dehumidifier, and fluorescent lights. Power ventilators and station coolers are common options. Since a CEV uses the same basic components as built-in-place units, the costs are about equal for materials. However, there are extra savings in design with well-detailed shop drawings, as well as savings in construction. Additional savings can be realized in land costs, with no land costs if existing rights-of-way can be used. Equipment found in CEV's include pumps, altitude valves, pressure regulating valves, and water meters. Telemetry can be used to monitor and control these functions as well as personnel and water intrusion alarms. Single unit responsibility from the design phase through warranty is the most valuable single asset a CEV will offer the water company, with design criteria, operational data, and maintenance instructions available for the CEV and the equipment contained inside. (Sand-PTT)
W90-03403

MANCHESTER WATER WORKS' SOURCE DEVELOPMENT CHARGE.
McLane, Graf, Raulerson and Middleton, Manchester, NH.
For primary bibliographic entry see Field 6C.
W90-03405

METHODOLOGIES AND STEPS ASSOCIATED WITH DEVELOPING A PUBLIC WATER WELL.
Maher (D.L.), Inc., North Reading, MA.
J. T. Morine.
Journal of the New England Water Works Association JNEWA6, Vol. 103, No. 3, p 165-169, November 1989.

Descriptors: *Water supply development, *Wells, *Well regulations, Geohydrology, Geology, Geophysics, Test wells, Observation wells.

In the development of a public water well, the first step undertaken is the gathering of all information on any preceding work, including a review of all hydrogeologic maps, U.S.G.S. groundwater favorability maps, surficial and bedrock quadrangles, bridge boring logs, monitoring wells, and all past test well exploration programs, and the preparation of a plot plan which accurately shows the land use in various parts of the community. Potential well sites are identified based on an understanding of the bedrock geology and the drainage system. Areas where favorable sediments are though to exist are evaluated, and when all areas of the community having favorable water bearing sediments are identified a process of elimination takes place to exclude previous unsuccessful test well sites and sites which are possible sites of contamination. Once possible locations are identified, geophysical techniques may be utilized such as seismic refraction surveys, earth resistivity measurements, magnetometer and/or VLF grids to help refine the best area to drill for test wells. If the test well shows a capacity from which experience has shown a higher yield can be projected, an observation well is driven to the same depth as the test well. If suggests that a permanent well is possible, this the appropriate state regulatory agency should be contacted to fulfill the requirements set forth by that body. A sanitary survey must also be undertaken to ascertain if all potential sources of pollution lie outside the area of presumed recharge. The next step usually entails a stressing of the aquifer by means of a prolonged pump test, preferably one in which the pumping rate is equal to that projected for the permanent well. Barrier and recharge boundaries must then be delineated, and observation and monitoring wells will be proposed which will confirm those assumptions. It may also be

advisable to determine the water chemistry and temperature of any nearby surface source. The method and frequency of drawdown measurements will be determined as well as the recovery readings. Any site-specific special conditions not normally associated with a pump test must be also be addressed. When all of this data has been assembled, it should be formulated into a report and forwarded to the proper state agency for review and comment. (Sand-PTT)
W90-03406

AIDS TRANSMISSION IN DRINKING WATER: NO THREAT.
California Dept. of Health Services, Berkeley. Viral and Rickettsial Disease Lab.
J. L. Riggs.
Journal of the American Water Works Association JAWWA5, Vol. 81, No. 9, p 69-70, September 1989. 17 ref.

Descriptors: *Path of pollutants, *Viruses, *Drinking water, *Human diseases, *AIDS.

Human immunodeficiency virus (HIV), the pathogen that causes AIDS in humans, can be transmitted in five ways: sexual contact with an infected individual; needle sharing by infected, intravenous drug users, transfusion of infected blood; exposure of wounds or cuts to the blood of body fluids of infected persons; and in utero transmission to infants by infected mothers. There is no evidence that HIV can be transmitted via a waterborne route. (Author's abstract)
W90-03470

EVALUATING TREATMENT PROCESSES WITH THE AMES MUTAGENICITY ASSAY.
Environclean, London (England).
D. K. Noot, W. B. Anderson, S. A. Daignault, D. T. Williams, and P. M. Huck.
Journal of the American Water Works Association JAWWA5, Vol. 81, No. 9, p 87-102, September 1989. 2 tab, 111 ref.

Descriptors: *Ames test, *Water treatment, *Mutagenicity, Evaluation, Ozonation, Chlorination.

The use of the Ames Salmonella assay for assessing the mutagenicity of water produced by various treatment processes is reviewed. Although chlorination is the most common means of disinfection in North America, chloramines, chlorine dioxide, and ozone have been shown to produce water that is less mutagenically active. Granular activated carbon (GAC) removes mutagens preferentially compared with parameters such as total organic carbon. In the absence of GAC, postchlorination typically increases mutagenicity. Inconsistent interstudy results with respect to the effects of ozone and metabolic activation (S9) and the capacity of GAS point to the role of raw water characteristics in the determination of treated water mutagenicity. In the case of ozone, dosage and contact time may also be important. (Author's abstract)
W90-03473

PILOT SCALE EVALUATION OF OZONE AND OTHER DRINKING WATER DISINFECTANTS USING MUTAGENICITY TESTING.
Alberta Univ., Edmonton. Dept. of Civil Engineering.
P. M. Huck, W. B. Anderson, E. A. Savage, R. C. von Borstel, and S. A. Daignault.
Ozone: Science and Engineering OZSEDS, Vol. 11, No. 3, 1989. 5 fig, 3 tab, 34 ref.

Descriptors: *Disinfection, *Mutagenicity, *Water treatment, *Chlorination, *Ozonation, *Activated carbon, Alberta, Chloramines, Chlorine dioxide, Ames test, Seasonal variation.

Mutagenicity produced by the oxidants chlorine, chloramines, chlorine dioxide and ozone when used in drinking water treatment was examined in a pilot scale study conducted at Edmonton, Canada. Both the Ames test, and a yeast assay using Saccharomyces cerevisiae were employed. In the Ames test, chlorination produced mutagenicity the most frequently; samples obtained following ozonation rarely were mutagenic. In the yeast assay, mutagenicity was seen only infrequently. Granular activated carbon effectively removed mutagenicity for a long period of time. Short term deteriorations in water quality attributable to weather events were often found to be significant in terms of mutagenicity. These effects were superimposed on longer term seasonal patterns. In winter, temperatures in edmonton sometimes remain below freezing for weeks at a time. This leads to a generally good and stable raw water quality, because there is no run-off to the river. Spring thaw produces elevated concentrations of organic matter; the magnitude of the peak depends on the winter's snowfall and any prior melting. Fall water is typically characterized by improving water quality as temperatures drop to below freezing, preventing the transport of decaying organic material to the river during precipitation events. (Author's abstract)
W90-03494

EFFECTS OF OZONATION, BIOLOGICAL FILTRATION AND DISTRIBUTION ON THE CONCENTRATION OF EASILY ASSIMILABLE ORGANIC CARBON (AOC) IN DRINKING WATER.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
K. van der Kooij, W. A. M. Hijinen, and J. C. Kruithof.
Ozone: Science and Engineering OZSEDS, Vol. 11, No. 3, p 297-311, 1989. 7 fig, 3 tab, 16 ref.

Descriptors: *Water treatment, *Ozonation, *Organic carbon, *Drinking water, Biological filters, Bacteria, Culturing techniques, Assimilable organic carbon.

The concentration of easily assimilable organic carbon (AOC) as determined with growth measurements using two bacterial cultures, increased linearly with ozone dosage at values below 1 mg $O3/mg$ of C. Moreover, a linear relationship was found between AOC increase and the decrease of UV absorbance of water after ozonation with various dosages. Biological filtration in water treatment reduced AOC concentrations, but the remaining values were above the AOC concentration before ozonation. This AOC removal was associated with an increased colony count in the filtrate. The AOC concentration of drinking water produced by the application of ozone in water treatment decreased during distribution. The greatest decrease was observed with the highest AOC concentration. In addition, the highest colony counts were found in this situation. These results indicate AOC determinations can be used for measuring the effects of biological filtration processes on the AOC concentration and for studiying aftergrowth phenomena in distribution systems. (Author's abstract)
W90-03496

TREATMENT OF SPA WATER WITH OZONE PRODUCED BY UV LIGHT.
Trojan Technologies, Inc., London (Ontario).
G. E. Whitby.
Ozone: Science and Engineering OZSEDS, Vol. 11, No. 3, p 313-324, 1989. 1 fig, 1 tab, 26 ref.

Descriptors: *Ozonation, *Disinfection, *Ultraviolet radiation, *Water treatment, Spas, Bacterial analysis, Chlorination, Comparison studies.

Some North American manufacturers are selling devices which produce ozone from UV radiation, which is pumped or sucked into spas, presumably to disinfect the water, without having to use chlorine. To test this claim, a private spa used by two people at least once a day was equipped with a UV radiation unit and an ozone (generating by UV) unit. Bacterial analysis were conducted during experiments carried out using chlorine alone, ozone generated by UV radiation, and ozone in combination with UV radiation. Heterotrophic plate counts, and counts of Staphylococcus aureus and Pseudomonas aeruginosa were lowest when using chlorine, next lowest when using ozone plus UV radiation, and highest when using UV-generated ozone. It is concluded that insufficient dissolved ozone is present for a sufficient reaction time to effect disinfection of these organisms by ozone generated UV radiation. The fact that the odor of ozone was present above the spa water indicates that contacting was also inefficient. (Author's abstract)
W90-03497

OZONE TREATMENT IN COOLING WATER SYSTEMS.
Toshiba Corp., Tokyo (Japan).
N. Kaiga, T. Seki, and K. Iyasu.
Ozone: Science and Engineering OZSEDS, Vol. 11, No. 3, p 325-338, 1989. 12 fig, 1 tab, 5 ref.

Descriptors: *Water treatment, *Ozonation, *Cooling water, *Pipelines, *Industrial water, Slime, Corrosion, Freshwater, Saline water, Aquatic life.

In the fresh water system, the separating effect of the ozonated water on the microorganisms, such as Sphaerotilus and Zoogloea, which adhere to the piping and form a slime is recognized. When the ozonated water is supplied intermittently to the piping without stopping the flow of the cooling water, a constant volume of cooling water can be maintained. At the velocity of 1 m/sec, the amount of metal corrosion produced by the ozonated water is reduced on mild steel, increased on copper and does not change on cast iron, when compared with that produced by the water containing no ozone. In the seawater system, since many substances are oxidized by the ozone, the same treatment as that in the freshwater system cannot be used. However, if the seawater in the cooling system can be replaced with ozone-containing air intermittently once a week, the adhesion of organisms such as barnacles and mussels to the piping can be prevented without having a negative effect on the other living oceanic organisms. (Author's abstract)
W90-03498

RELATIONSHIPS BETWEEN ACTINOMYCETE POPULATIONS AND ORGANIC MATTER DEGRADATION IN LAKE MULWALA, SOUTHEASTERN AUSTRALIA.
Murray-Darling Freshwater Research Centre, Albury (Australia).
For primary bibliographic entry see Field 2H.
W90-03513

REDUCTIVE DEHALOGENATION AND BIOOXIDATION OF CHLORINATED ETHANES AND METHANES BY ACETOCLASTIC METHANOGENS.
Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences.
For primary bibliographic entry see Field 5D.
W90-03554

5G. Water Quality Control

CASE STUDY AND PROPOSED DECONTAMINATION STEPS OF THE SOIL AND GROUNDWATER BENEATH A CLOSED HERBICIDE PLANT IN GERMANY.
Dekonta G.m.b.H., Mainz (Germany, F.R.).
H. J. Jurgens, and R. Roth.
Chemosphere CMSHAF, Vol. 18, No. 1-6, p 1163-1169, 1989. 2 fig, 7 ref.

Descriptors: *Lindane, *Dioxins, *Cleanup, *Water pollution treatment, *Pesticides, *Decontamination, *Soil contamination, *Groundwater pollution, *Herbicides, Case studies, West Germany, Organic compounds, Pollutant identification, Sampling, Chemical degradation, Cleanup operations, Isomers, Chlorinated hydrocarbons.

A chemical pharmaceutical plant in Hamburg, Germany, which produced morphine and codeine, began production of pesticides in 1951, beginning with the manufacture of hexachlorcyclohexane (HCH) and the corresponding isolation of lindane. The inactive isomers from this production were stored on site. Thermal decomposition of the HCH

isomers produced residues that were first discovered in 1984 and that consisted of polychlorinated dioxins. The case history of the removal of these residues from the immediate environment is reviewed. The groundwater below the contaminated soil was also contaminated with chlorobenzenes, chlorophenols and hexachlorocyclohexane. Altogether, 4081 meters of cores were analyzed geologically and 2,652 soil samples were taken for chemical analysis. Groundwater samples were taken from 74 wells. Probably because of its rapid degradation, only low concentrations of 2,4,5-T were detected in the surrounding soil. Approximately 88% of the soil samples contained less than 10 mg/kg of chlorobenzene, hexachlorocyclohexane and chlorophenol. PCDDs, especially 2,3,7,8-TCDD, were found nearer to the surface. Two possible sources of the PCDDs and PCDFs in the pesticide production were production of 2,3,7,8-TCDD with a low content of higher chlorinated PCDDs and PCDFs, and thermal decomposition of hexachlorocyclohexane isomers, mainly to higher chlorinated PCDDs and PCDFs, with a low content of 2,3,7,8-TCDD. In areas of high 2,3,7,8-TCDD concentrations, approximately 2600 cu m of soil was excavated to depths ranging from 0.5-4.0 m and stored in large bags until it could be decontaminated. From early 1986 to October 1987 nearly 6 tons of organic material, mainly chlorobenzenes, have been pumped out of the bottom of two wells. Although it is believed that this contamination does not pose a risk to the ecosphere, plans are to excavate areas of high contamination levels followed by thermal decontamination and refilling the soil. (Friedmann-PTT)
W90-02616

PRESERVATION AND RESTORATION OF THE WATER RESOURCES OF THE ARAL SEA--AN URGENT NATIONAL ECONOMIC PROBLEM.
V. S. Altunin.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 2, p 65-72, August 1989. 2 fig, 1 tab.

Descriptors: *USSR, *Aral Sea, *Watershed management, *Lake restoration, *Sea level, Runoff, Canal linings, Crop rotation, Desalination, Syr Darya River, Ama Darya River.

Large water management and reclamation facilities and the creation of agroindustrial complexes mainly for the production of cotton, rice, and other crops under conditions of increasing volumes of consumptive use of water for irrigation are being carried out without due consideration of the ecological consequences for the Aral Sea (in the U.S.S.R.) and with a pronounced worsening of the sanitary and epidemiological conditions in this basin. As a result of the cessation of the runoff of the Syr Darya River and considerable reduction of the runoff of the Amu Darya River, the level of the Aral Sea has dropped by 13 m and is continuing to drop intensely. The water area of the Aral Sea has decreased by one-third, a multitude of islands and shoals have appeared. Intense drying and salinization of the lands in the Amu Darya and Syr Darya deltas is accompanied by a change in the local climate, which in the future will lead to the destruction of the ecosystem of the Aral basin. The catastrophic drop of the Aral Sea level right now is forming a number of social, economic, climatic, and ecological problems. Intensification of deflation processes leading to the transport of salts and the formation of sand-salt storms is causing the greatest disquiet. Watertight coatings on the existing water-conveying canals, introduction of crop rotation, removal of low-productivity saline lands, construction of new lined canals, and use of the desalinized and mineralized subsurface waters under the irrigation systems would help preserve water. Delivery of the surface collecting drain waters from the entire basin into the Amu Darya, Syr Darya, and Aral Sea, and creation of automated water accounting are also suggested. Use of wind and solar energy for desalination of mineralized waters and transfer of waters from Siberian rivers by pipelines to the Aral Sea basin would improve drinking water supplies. It is technically possible to realize the recommended measures within 5-10 years, to preserve the Aral Sea, and to gradually approach a solution to the problem of restoring the ecosystem of the Aral-Amu Darya water basin. (Mertz-PTT)
W90-02692

WATER QUALITY MANAGEMENT IN CANALS AND PIPELINES.
For primary bibliographic entry see Field 8B.
W90-02694

WATER-QUALITY MANAGEMENT THROUGH COMBINED SIMULATION-OPTIMIZATION APPROACH.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
D. H. Burn.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 115, No. 5, p 1011-1024, October 1989. 2 fig, 6 tab, 17 ref.

Descriptors: *Water quality management, *Wastewater treatment, *Waste load, *Model studies, Cost analysis, Simulation analysis, Optimization, Decision making.

A modeling technique for water-quality management that incorporates both simulation and optimization is presented. The proposed methodology should be of use in the allocation of waste load for a number of dischargers located on a water body. A Monte Carlo simulation model is utilized to generate a series of water quality responses that lead to the formulation of a constraint set for the optimization model. Repeated solution of the optimization model, using an appropriate mathematical programming technique, yields a distribution for the required treatment cost. Additionally, the distribution for the required pollutant removal fraction at each of the point source locations is obtained from the combined use of simulation and optimization. From the treatment cost distribution function attractive alternatives can be identified for further analysis prior to the implementation of a water-quality management plan. An example is presented that demonstrates the enhancement of the decision-making process by reducing the number of solutions the decision maker must consider as viable alternatives. (Author's abstract)
W90-02723

SELECTION OF RECEPTOR SITES FOR OPTIMIZED ACID RAIN CONTROL STRATEGIES.
Texas A and M Univ., College Station. Dept. of Civil Engineering.
S. A. Batterman.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 115, No. 5, p 1046-1058, October 1989. 4 fig, 12 ref.

Descriptors: *Acid rain, *Path of pollutants, *Fate of pollutants, *Water pollution control, *Air pollution effects, Optimization studies, Environmental policy, Model studies, Computer models.

A procedure was developed to identify the receptor sites which influence optimized emission abatement strategies. The mathematical formulation of targeted emission control strategies was developed by considering the objective of minimizing total control costs subject to achieving deposition targets. Emission sources are classified into categories based on geographical region, source type or other features; classification based on countries or states is most common. Cost curves giving annualized emission abatement costs are developed by considering the abatement options, fuel substitution, etc., available in each source category. The 'influential receptors' are the most critical sites in terms of meeting environmental objectives. Influential receptors represent only a small portion of the modeled region. After their identification, standard optimization techniques may be used. The procedure increases the speed of optimization, decreases memory requirements, and enables the solution of realistic problems using microcomputers. Influential receptors are found for several emission abatement strategies aimed at reducing peak concentrations and surface depositions of sulfur and nitrogen in North America and Europe. (White-Reimer-PTT)
W90-02724

STORING SEDIMENT AND FREEING FISH.
Army Engineer District, Portland, OR.
B. McCracken.
Civil Engineering, Vol. 59, No. 9, p 58-60, September 1989. 2 fig.

Descriptors: *Earth dams, *Rockfill dams, *Sediment control, *Fish handling facilities, *Toutle River, Salmon, Trout, Fish migration, Fish barriers, Fish ladders, Spillways, Dam construction, Contracts, Oregon.

The Portland, OR, district of the Corps of Engineers is currently constructing an earth and rockfill dam on the North Fork Toutle River to trap and store the sediment from the Mount St. Helens eruption that threatens the Cowlitz and Columbia river systems and yet also allow for salmon and steelhead migration on the river system. The main features are the embankment dam, the spillways, the outlet works, and, of course, a facility to aid fish migration. The fish collection facility consists of a fish barrier across the river, a fish ladder, a collection pool, and a lock. Fish migrating upstream will be trapped and hauled. The lock will be used to move fish from the collection pool and onto trucks. A complicated outlet works system is being installed to trap and store sediment efficiently. Construction of the dam system is expected to continue on schedule until completion in Feb. 1990. The construction contract for the dam system was awarded to Granite Construction Co. for $156.5 million. (Cutty-PTT)
W90-02734

EPA'S APPROACH TO EVALUATING AND CLEANING UP GROUND WATER CONTAMINATION AT SUPERFUND SITES.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
J. L. Haley, D. J. Lang, and L. Herrinton.
Ground Water Monitoring Review GWMRDU, Vol. 9, No. 4, p 177-183, 1989. 8 ref.

Descriptors: *Water pollution treatment, *Cleanup, *Landfills, *Groundwater pollution, *Superfund sites, *Environmental protection, Policy making, Decision making, Remedies.

EPA's approach for developing, evaluating, and selecting ground water response actions at Superfund sites with contaminated ground water involves a series of key decisions to support necessary actions. These actions include the following: (1) planning how the site will be managed, (2) determining data needs, (3) determining remedial action objectives, (4) developing alternatives, and (5) selecting and implementing the remedy. The key decisions should reflect a policy and decision-making approach developed within the framework of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA 1980) as amended by the Superfund Amendments and Reauthorization Act (SARA 1986) and program policies to implement these acts. A flexible, iterative process, by which ground water remedies can be identified, evaluated, selected, and implemented at Superfund sites beginning with initial site investigation tasks and ending with evaluation of implemented actions is outlined. Proper consideration of the factors presented should result in an efficient, effective procedure for making remedial action decisions for contaminated ground water that ensures protection of human health and the environment. (Author's abstract)
W90-02773

CONSERVING RIVERS IN SOUTHERN AFRICA.
Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
For primary bibliographic entry see Field 2E.
W90-02809

COASTAL LAGOONS OF BRITAIN: AN OVERVIEW AND CONSERVATION APPRAISAL.
Cambridge Univ. (England). Dept. of Zoology.
For primary bibliographic entry see Field 2L.
W90-02810

CHILDHOOD LEAD POISONING.
Massachusetts Dept. of Public Health, Boston.
Childhood Lead Poisoning Prevention Program.
For primary bibliographic entry see Field 5F.
W90-02818

SUPERFUND RECORD OF DECISION: OPER-ATING INDUSTRIES, CA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-128391.
Price codes: A03 in paper copy, A01 in microfiche.
Report No. EPA/ROD/R09-88/017, November 1987. 28p, 8 fig, 3 tab.

Descriptors: *Hazardous wastes, *Leachates, *Sludge disposal, *Landfills, *Volatile organic compounds, *Superfund, *Cleanup operations, *Water pollution treatment, Monterey Park, Benzene, Toluene, Vinyl chloride, Trichloroethene, Organic compounds, Costs, Air stripping, Granular activated carbon.

The Operating Industries, Inc. (OII) site, consisting of a 190-acre landfill, is located in Monterey Park, CA. The City of Montebello, which borders the southern parcel of the landfill, has a population of 52,929 residents. Several residences are located immediately adjacent to the landfill boundaries. Between 1948 and 1984, the landfill was used for the disposal of municipal and industrial waste. Over its 36-year life span, the OII landfill has accepted several types of waste, including: residential and commercial refuse; water-insoluble, nondecomposable inert solids; liquid wastes; various hazardous wastes including wastewater treatment sludge from production of chrome oxide green pigment; and slop oil emulsion solids and tank bottom sludges (leaded) from petroleum refining operations. Beginning in 1979, gas was extracted from the landfill for processing and sale. EPA has conducted a number of emergency actions to mitigate potential threats to public health and the environment. Both landfill gas and leachate are generated by the OII site. Since October 1984, collected leachate has been stored onsite in tanks and transported to a permitted offsite treatment facility. Approximately 10,000 gallons of leachate will be collected before implementation of a final site remedy. The leachate generated contains volatile organic compounds including: benzene, trichloroethene, toluene, and vinyl chloride. The selected remedial action for this site includes onsite treatment of leachate and other collected hazardous liquids by air stripping and granular activated carbon adsorption in a facility constructed at onsite location B with discharge to the Los Angeles County Sanitation District sewerage system. The estimated 5-year capital cost for this remedial action is $1,900,000 with estimated 5-year annual operation and maintenance of $700,000. (Author's abstract)
W90-02916

SUPERFUND RECORD OF DECISION: ODESSA CHROMIUM II, TX.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-128342.
Price codes: A04 in paper copy, A01 in microfiche.
Report No. EPA/ROD/R06-88/027, March 1988. 72p, 3 fig, 4 tab.

Descriptors: *Hazardous wastes, *Superfund, *Cleanup operations, *Chromium, *Water pollution treatment, Groundwater quality, Texas, Water pollution sources, Injection, Groundwater pollution, Aquifers, Costs, Electrochemistry, Chemical treatment.

The Odessa Chromium II site consists of chromium (Cr) contaminated wells within 200 acres of residential, commercial, and industrial properties and facilities just outside the northwestern city limits of Odessa, Ector County, Texas. Nearly every residence or commercial facility is served by one or more water wells completed in the underlying Trinity Aquifer, which offers the only source of potable groundwater. Two separate contaminant plumes are bounded by the site: 5329 Andrews Highway, and 57th Street and Andrews Highway. In 1970, local health department authorities investigated a complaint of contaminated (5.5 mg/L Cr) well water on the property to the south of 5329 Andrews Highway. At that time, wastewater analysis did not indicate the presence of Cr despite the presence in 1978 of a cleaning vat solution, stored in partially buried steel tanks, which contained 2.8 mg/L of Cr. One of the storage tanks was discovered leaking and the tanks were subsequently removed. The facility at 57th Street and Andrews Highway has been in operation since about 1950. Chromates were utilized in the cooling system until about 1976. This system was apparently tied into one of the plant's water wells and during occasional slow downs, cooling water could have been inadvertently back flushed into the well since there was no check valve. The plant also utilized an unlined pit for the disposal of contaminated wastewater, including chromate wastes from the cooling water system, until about 1977. The first operable unit, signed in September 1986, provided for the extension of the city's water supply until final groundwater remediation is complete. Although Cr is the primary contaminant of concern to the groundwater, other inorganics have been found in the soil. The selected remedial action for this site includes: groundwater pump and treatment using electrochemical techniques with reinjection into the Trinity Aquifer; and groundwater monitoring. A treatability study will be conducted during the system design phase of the project to aid in designing an appropriate treatment system. The estimated present worth cost for this remedial action is $3,618,000. (See also W90-02972) (Author's abstract)
W90-02917

SUPERFUND RECORD OF DECISION: CENTRAL CITY/CLEAR CREEK, CO.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-128383.
Price codes: A04 in paper copy, A01 in microfiche.
Report No. EPA/ROD/R0-88/019, March 1988. 71p, 1 fig, 3 tab.

Descriptors: *Superfund, *Cleanup operations, *Water pollution treatment, *Colorado, *Acid mine drainage, Water pollution prevention, Water pollution sources, Aluminum, Arsenic, Cadmium, Chromium, Lead, Manganese, Nickel, Silver, Copper, Fluorides, Zinc, Heavy metals, Costs, Monitoring, Slope stabilization, Fluorides.

The Clear Creek/Central City Superfund site is located approximately 30 miles west of Denver in Clear Creek and Gilpin Counties, CO. The site consists primarily of acid mine drainages from five mine tunnels and adjacent milling and rinsing wastes. Currently, acid mine drainage and runon and runoff from the tailings and waste rock piles have affected downstream surface water quality. In addition to the direct discharge from the mine tunnels, contaminated water may enter Clear Creek and North Clear Creek during overland sheet flow. This occurs during rapid snowmelt and storms. The resulting surface flow across the tailings and waste rock piles dissolves soluble minerals and transports particulate tailings and waste rock materials into the creeks. All this results in elevated creek acidity and metal loads. The introduction of tailings and waste rock into the creeks could also occur due to catastrophic collapse of tailings and waste rock piles during a flash flood or as a result of undercutting of the base of the pile under any flow regimen. The discharge from the five tunnels was addressed in the first remedial action operable unit for this site. The primary contaminants of concern for human receptors in surface water include: aluminum, arsenic, cadmium, chromium (IV), lead, manganese, nickel, and silver. For aquatic receptors, this list expands to include: copper, fluoride, and zinc. The selected remedial action for this site includes: slope stabilization at the Big Five Tunnel and Gregory Incline; monitoring of the gabion wall at the Gregory Incline; and runon control at the Argo Tunnel, Big Five Tunnel, Gregory Incline, National Tunnel, and the Quartz Hill Tunnel. The estimated present worth cost for this remedial action is $1,049,600. (Author's abstract)
W90-02918

SUPERFUND RECORD OF DECISION: PRISTINE, OH.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-128326.
Price codes: A04 in paper copy, A01 in microfiche.
Report No. EPA/ROD/R05-88/060, December 1987. 42p, 11 fig, 11 tab.

Descriptors: *Hazardous wastes, *Waste dumps, *Superfund, *Water pollution treatment, *Cleanup operations, *Ohio, Incineration, Acids, Solvents, Pesticides, Polychlorinated biphenyls, Volatile organic compounds, Tetrachloroethene, Trichloroethylene, Benzene, Excavation, Vitrification, Costs.

In 1974, Pristine, Inc. began liquid waste disposal operations at a site located in southwestern Ohio. In the spring of 1977, Pristine, Inc. obtained a permit to operate a liquid waste incinerator. In April 1979, as many as 8,000 to 10,000 drums and several hundred thousand gallons of bulk liquids were found onsite, consisting of acids, solvents, pesticides, polychlorinated biphenyls (PCBs), and other chemicals. Disposal operations were ordered to shut down in September 1981, in accordance with a partial consent order with the State of Ohio. From June 1980 to November 1983, much of the onsite waste was removed in accordance with the Consent Decree between Pristine, Inc. and the Ohio EPA. Wastes stored and subsequently removed from the site during this period included paint sludges, lab packs, flammable solvents, cyanide wastes, pesticides, chlorinated solvent sludge, DDT, 'neutralized' acid sludges, PCB-contaminated soils, incinerator ash, and solvent/sludge mixtures. Between March 1984 and July 1984, soil and waste removal activities addressing immediate hazardous site conditions were performed by some of the potentially responsible parties. These activities did not address the long-term risks associated with the site. The results of the Remedial Investigation/Feasibility Study indicated that > 90 compounds were detected in the soil, groundwater, surface water, and sediments including: volatile organic compounds (VOCs) (tetrachloroethene, trichloroethylene, benzene), organics, inorganics (metals), and pesticides (dioxin in soils and sediments only). The selected remedial action for this site includes: excavation and onsite consolidation of 1,725 cu yd of contaminated soils and sediments with in situ vitrification of an average of 37,000 cu yd (average of 10 ft across the entire 2.2-acre site) of contaminated soils and sediments followed by putting a vegetative soil cover over the vitrified mass; groundwater extraction and treatment using air stripping with carbon off-gas and offsite discharge to a creek; decontamination, demolition, and offsite disposal of all onsite structures in a non-RCRA landfill; installation of a french drain; and implementation of deed and access restrictions. The estimated present worth cost for this remedial action is $17,094,000 with annual operation and maintenance costs of $94,800. (Author's abstract)
W90-02919

SUPERFUND RECORD OF DECISION: CHEROKEE COUNTY/GALENA, KS.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-128375.
Price codes: A03 in paper copy, A01 in microfiche.
Report No. EPA/ROD/R07-88/010, December 1987. 35p, 2 fig, 5 tab.

Descriptors: *Mine wastes, *Groundwater pollution, *Heavy metals, *Superfund, *Cleanup operations, *Water pollution treatment, Kansas, Groundwater quality, Aquifers, Pipelines, Well water, Drinking water, Cadmium, Lead, Selenium, Zinc, Costs.

Group 5G—Water Quality Control

The Cherokee County site, the Kansas portion of the Tri-State Mining District, is located in the extreme southeastern corner of Kansas. The Galena subsite is characterized by surface mining waste features that impact the quality of the shallow groundwater aquifer. This aquifer is a primary source of drinking water for approximately 1,050 people. EPA investigations of the Galena subsite conducted in 1986 and 1987 demonstrated that the shallow groundwater aquifer and surface water are contaminated with elevated concentrations of metals. Due to the concern for the health of persons drinking this water, EPA conducted a removal action and installed water treatment units on these wells. This removal action was considered a temporary protective measure. The primary contaminants of concern observed in the private wells include: cadmium, lead, selenium, and zinc. The selected remedial action for this site provides for collection of water from the aquifer through existing wells owned by the City of Galena with subsequent distribution of that water through a pipeline network to 418 houses, businesses, and farms outside of the Galena municipal water system but within the subsite. Additional capacity for the expanded system will be rehabilitated to provide additional capacity for the expanded system. If rehabilitation becomes infeasible due to unforeseen onsite technicalities, a new deep aquifer well may be drilled to provide additional waters. The remedy includes acquiring the construction and equipment necessary to set up a water supply to this area. The estimated present worth cost for this remedy is $5,300,000 with annual operation and maintenance costs of $100,000. (Author's abstract)
W90-02920

WASTEWATER TREATMENT AND RECEIVING WATER BODY INTERACTIONS.
Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab.
For primary bibliographic entry see Field 5C.
W90-02921

SUPERFUND RECORD OF DECISION: ODESSA CHROMIUM I, TX.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-128334.
Price codes: A04 in paper copy, A01 in microfiche.
Report No. EPA/ROD/R06-88/026, March 1988. 87p, 4 fig, 4 tab.

Descriptors: *Texas, *Metal-finishing wastes, *Superfund, *Cleanup operations, *Water pollution treatment, Chromium, Groundwater pollution, Water pollution sources, Metal-finishing wastes, Soil contamination, Costs, Aquifers, Injection, Drinking water, Potable water, Trinity Aquifer, Monitoring.

The Odessa Chromium I site consists of a series of chromium contaminated wells within 300 acres of residential, commercial, and industrial properties and facilities just outside the city limits of Odessa, Texas. Nearly every residence or commercial facility is served by one or more water wells completed in the underlying Trinity Aquifer, which offers the only source of potable groundwater. Two potential sources of groundwater contamination at the site have been identified: 4318 Brazos property, and 2104 West 42nd Street. In December 1979, the Texas Department of Water Resources identified the 4318 Brazos property as a potential source of chromium contamination. Several chrome plating operations functioned at this property between 1972 and 1977. The site at 2104 West 42nd Street is presently operating as a metal plating facility. This property was first identified as a possible source of groundwater contamination in 1978. The first operable unit Record of Decision, signed in September 1986, provided for the extension of the city's water supply until final groundwater remediation is complete. Although chromium is the primary contaminant of concern affecting the groundwater, other inorganics have been found in the soil. The selected remedial action for this site includes: demolition and disposal of a building at 4318 Brazos; groundwater pump and treatment using electrochemical techniques with reinjection into the Trinity Aqui-

fer; and groundwater monitoring. The estimated present worth cost for this remedial action is $2,836,000. (See also W90-02917) (Author's abstract)
W90-02927

SUPERFUND RECORD OF DECISION: OLD MIDLAND PRODUCTS, AR.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-128359.
Price codes: A03 in paper copy, A01 in microfiche.
Report No. EPA/ROD/R06-88/028, March 1988. 38p, 1 fig, 3 tab.

Descriptors: *Superfund, *Cleanup operations, *Water pollution treatment, *Arkansas, *Creosote, *Pentachlorophenol, Polycyclic aromatic hydrocarbons, Soil contamination, Groundwater pollution, Sludge, Costs.

The Old Midland Products site is an abandoned creosote and pentachlorophenol wood preserving plant and sawmill, located in Ola, Yell County, Arkansas. The site is flat with a total area of approximately 37 acres. Between 1969 and 1970, Old Midland Products was in operation treating wood with creosote. Effluents from the treatment process containing pentachlorophenol (PCP) and polynuclear aromatic compounds were discharged into lagoons 1 or 3 and other lagoons via a moveable discharge pipe. Pond overflows have occurred with drainage to the intermittent stream west of the lagoons. The land, originally owned by the Old Midland Products Co., was sold in 1979 to the Plainview-Ola Economic Trust Inc. Approximately 9,000 to 21,000 cu yd of soil, 850 cu yd of drainage sediments, 450,000 gallons of groundwater, 620,000 gallons of lagoon fluids, and 2,770 cu yd of lagoon sludges are contaminated with PCP and polynuclear aromatic hydrocarbons (secondarily). The selected remedial action for this site includes: onsite thermal destruction of the contaminated surface soils, lagoon sludges, and drainageway sediments with onsite disposal of waste residuals and a vegetated cover; and groundwater pump and treatment using carbon adsorption. Cost estimates for these actions have not yet been fully developed and recovery enforcement action will be pursed at a later date. (Author's abstract)
W90-02928

HAZARDOUS WASTE REDUCTION AT THE SAVANNAH RIVER PLANT.
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Lab.
P. P. McIntyre, E. G. Orebaugh, and H. F. Sturm.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-011241.
Price codes: A02 in paper copy, A01 in microfiche.
Report No. DP-MS--88-4, 1988. 2 p, 3 ref. DOE Contract DE-AC09-76SR00001.

Descriptors: *Water pollution prevention, *Hazardous wastes, *Savannah River Plant, Costs, Regulations, Solvents, Lead, Aluminum, Lithium, Nitrates.

As part of an overall site program, the Savannah River Laboratory (SRL) is actively pursuing methods to reduce volumes of hazardous waste. A major part of this program is directed at identifying non-hazardous materials which can be substituted for hazardous ones. Examples of successful hazardous waste reduction are discussed including the source, the regulatory standards, and the site impact of eliminating or reducing waste--specifically with respect to: leaded oil waste reduction, aqueous degreasers as substitutes for halogenated solvents, liquid scintillation wastes, lithium aluminum dross, and use of nitrate wastes as fertilizer. A 15% reduction was achieved in the hazardous waste inventory during 1987. (Lantz-PTT)
W90-02930

SUPERFUND RECORD OF DECISION: NASCOLITE CORPORATION, NJ.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-128300.
Price codes: A06 in paper copy, A01 in microfiche.
Report No. EPA/ROD/R02-88/059, December 1987. 105p, 6 fig, 2 tab, 6 append.

Descriptors: *Superfund, *Water pollution treatment, *Cleanup operations, *New Jersey, *Organic compounds, Polymethyl methacrylate, Plexiglass, Drinking water, Volatile organic compounds, Groundwater pollution, Aquifers, Costs.

The Nascolite Corporation site is located in the cities of Millville and Vineland, Cumberland County, New Jersey. The 17.5 acre site, over one-half of which is wooded, is in an area zoned as residential and industrial. Several homes exist near the site and rely on potable wells for drinking water. Between 1953 and 1980, the Nascolite Corporation manufactured polymethyl methacrylate (MMA) sheets, commonly known as Plexiglass. Waste residues from the distillation of scrap acrylic, a manufacturing by-product, were stored in buried tanks onsite. Perforation in one of the tanks excavated indicated the possibility of liquid waste leaking into the soils. In 1981 and 1983, the New Jersey Department of Environmental Protection (NJDEP) sampled onsite and found in significant concentrations of volatile organic compounds (VOCs) in the groundwater. NJDEP identified > 100, fifty-five gallon drums and several buried tanks on the site, most of which had been subsequently removed from the site by the property owner. The remaining drums were removed by EPA. The primary contaminants of concern affecting both groundwater and soil include: VOCs, base/neutrals, and MMA. The selected remedial action for this site includes: groundwater pump and onsite treatment using a method determined through pilot testing with reinjection into the aquifer; performance of additional soil and onsite building studies to determine appropriate future remedial measures; and provision of an alternate water supply for potentially affected residents. The estimated capital cost for this remedial action is $609,000 with annual operation and maintenance of $266,000. (Author's abstract)
W90-02933

RCRA (RESOURCE CONSERVATION AND RECOVERY ACT) FACILITY INVESTIGATION (RFI) GUIDANCE. VOLUME 3: AIR AND SURFACE WATER RELEASES.
NUS Corp., Gaithersburg, MD.
For primary bibliographic entry see Field 5B.
W90-02936

HYDRODYNAMICS AND WATER QUALITY MODELING OF A WET DETENTION POND.
Virginia Univ., Charlottesville. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-03022

COMPUTER MODEL FOR THE ESTIMATION OF EFFLUENT STANDARDS FOR PRIORITY POLLUTANTS FROM A WASTEWATER DISCHARGE BASED UPON AQUATIC LIFE CRITERION OF THE RECEIVING STREAM.
J. R. Nuckols, S. F. Thomson, and A. G. Westerman.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 357-362, 3 fig, 7 ref.

Descriptors: *Model studies, *Water pollution control, *Kentucky, *Pollution load, *Water quality standards, *Risks, *Computer models, Streamflow, Parameter estimation model, Priority pollutants, Statistics, Clean Water Act, Management planning, Wastewater facilities, Ecosystems.

A computer model, the parameter estimation model, has been developed to provide the user with a numerical calculation of risk associated with the discharge of priority pollutants, as defined by the U.S. Environmental Protection Agency, on the aquatic ecosystem of the receiving stream. The

model uses an application of the SAS statistical computing system in conjunction with standard mass balance analytical techniques to determine the risk associated with the discharge of any pollutant for which an ambient water quality criterion has been established. The model was developed primarily to assist in the determination of specific numerical values to be used as limits for priority pollutants in permits required by the Federal Clean Water Act. The development of this model is discussed; data requirements and procedures for its application are given; and examples of the use of the model as a policy-support tool are given in which specific effluent limits were prescribed for two publicly owned treatment works in Kentucky. (See also W90-03036) (Author's abstract)
W90-03088

OPTIMIZATION OF WATER QUALITY IN RIVER BASIN.
Bulgarian Academy of Sciences, Sofia. Inst. of Water Problems.
I. Dimitrova, and J. Kosturkov.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 405-410, 2 tab, 2 ref.

Descriptors: *Model studies, *Water pollution control, *Water quality management, *Optimization, *Wastewater treatment, *Pollution load, Management planning, Hydrologic models, Chemical oxygen demand, Biochemical oxygen demand, Nitrogen, Ammonia, Phosphorus, Oil, Water pollution control.

An alternative management scheme for water quality maintenance in a river basin is presented. The two basic planning problems are to determine the desired level of water quality and to develop a waste management program. The optimization problem is formulated here with the objective being to minimize the sum of waste removal costs for some dischargers. This is carried out in terms of determining an optimal design procedure for the individual plants and then optimizing the overall treatment costs with the constraint of stream quality preservation. Because of a water deficit in the experimental basin during the low-water period, the model also includes the possibility of controlling the river discharge. The procedure used is to determine the optimum stages of wastewater treatment for keeping one parameter within the standard limits, then to select from the degrees of treatment obtained in the first stage a combination that will deal with the remaining parameters. The levels of treatment for five different dischargers were obtained and the total cost of controlling insolubles, chemical oxygen demand, biochemical oxygen demand, nitrogen, ammonia, phosphorus, and oil were determined. One of the dischargers needed to use secondary treatment; the rest could use primary treatment only. The total optimal cost was 15 million leva/year. (See also W90-03036) (Rochester-PTT)
W90-03095

KARST HYDROGEOLOGY AND KARST ENVIRONMENT PROTECTION. VOLUME 2.
For primary bibliographic entry see Field 2F.
W90-03104

FISSURED AQUIFEROUS KNOWLEDGE: TRUMPS AGAINST POLLUTION.
Lille-1 Univ., Villeneuve d'Ascq (France). Lab. de Geologie Appliquee.
For primary bibliographic entry see Field 2F.
W90-03160

GROUND-WATER PROTECTION IN THE UNITED STATES.
Geological Survey, Reston, VA.
J. E. Moore.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1059-1063, 6 ref.

Descriptors: *Water pollution control, *Legislation, *Regulations, *Water pollution prevention, *Environmental protection, *Groundwater pollution, Federal jurisdiction, Water quality control, Groundwater quality, Superfund.

Groundwater is a vital natural resource in the United States. It is a major source for drinking water, agriculture, and industry. It is the source of drinking water for 50% of the Nation's population and 95% of the rural population. Groundwater has been relied upon for generations with little thought given to the possibility of contaminating the supply. However, there is increasing public concern because of news reports of contamination by toxic or hazardous chemicals. The United States Congress has enacted laws to regulate substances that are the major sources of groundwater contamination, provide funds to clean-up contaminated sites, and has established programs to protect groundwater. The Federal laws that protect groundwater are: the Safe Drinking Water Act, the Resource Conservation and Recovery Act, and the Comprehensive Environmental Response Compensation and Liability Act (Superfund). (See also W90-03104) (Author's abstract)
W90-03169

NUCLEAR GROUNDWATER PROTECTION.
Bergakademie Freiberg (German D.R.). Dept. of Geosciences.
H. P. Jordan.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1064-1072, 4 fig, 1 tab, 7 ref.

Descriptors: *Path of pollutants, *Water pollution control, *Water pollution prevention, *Fate of pollutants, *Groundwater pollution, *Radioisotopes, Radioactive wastes, Nuclear energy, Geohydrology, Chemical properties.

Geohydrological aspects of groundwater pollution by man-made radionuclides are considered. Within this problem, geohydrologists have to regard long-term processes in a broad perspective. The use of nuclear energy requires guaranteeing the safety of working management and waste disposal with the prevention of negative effects for the hydrosphere, atmosphere and biosphere. This requires cooperation between politicians, decision makers, technicians, and scientists. Geoscientists and geohydrologists especially occupy a key position, because groundwater is the main factor in transport. The following radionuclides and their fission products, as well as their mobilization, migration and fixation are of interest: 3-H, 14-C, 55-Fe, 60-Co, 63-Ni, 85-Kr, 90-Sr, 93-Zn, 99-Tc, 106-Ru, 107-Pd, 125-Sb, 129-J, 131-J, 134/135-Cs, 147-Pm, 151-Sm, 154/155-Eu, 210-Br, 210-Po, 212-Pb, 222-Rn, 225/226-Ra, 227-Ac, 229/230-Th, 234, 235, 236, 238-U, 237-Np, 238/239, 240, 241-Pu, 241/243-Am, and 244/245-Cm. Nobody knows, at present, about all the behavior and reactions of radionuclides in different groundwater surroundings and in combination with other radionuclides and elements. So it will be necessary to start a coordinated, controlled international program in order to investigate the most relevant nuclides, with respect to their retardation under different circumstances: in different geological structures and lithofacies, in different geohydrological conditions, and against different natural or artificial barriers. (See also W90-03104) (Lantz-PTT)
W90-03170

BASIC HYDROGEOLOGICAL CHARACTERISTICS OF KARST-WATER INFILLED MINERAL DEPOSITS AND THE HAZARD PREVENTION, CONTROL AND UTILIZATION OF KARST WATER IN CHINA.
Zhengding Inst. of Hydrogeology and Engineering Geology (China).
For primary bibliographic entry see Field 2F.
W90-03173

MINING DRAINAGE OF A KARSTIC AQUIFER AND THE RELATED PROTECTION

PROBLEMS (OLKUSZ MINING DISTRICT, POLAND).
Academy of Mining and Metallurgy, Krakow (Poland). Inst. of Hydrogeology and Engineering Geology.
For primary bibliographic entry see Field 2F.
W90-03174

TREATMENT OF HAZARDOUS WASTE LEACHATE: UNIT OPERATIONS AND COSTS.
PEI Associates, Inc., Cincinnati, OH.
J. L. McArdle, M. M. Arozarena, and W. E. Gallagher.
Pollution Technology Review No. 151. Noyes Data Corporation, Park Ridge, New Jersey. 1988. 111p.

Descriptors: *Water pollution prevention, *Water pollution treatment, *Wastewater treatment, *Wastewater treatment, *Leachates, *Hazardous wastes, Costs, Waste treatment, Economic aspects, Pretreatment of wastewater, Physical treatment, Chemical treatment, Biological treatment, Organic compounds, Environmental engineering, Inorganic compounds, Water pollution control.

Twenty technologies are described that have been employed to treat leachates from hazardous waste sites. This information will be useful to industrial and engineering firms which must deal with leachate treatment. The twenty unit operations are reviewed for their applicability to the treatment of hazardous waste leachate. They are classified into the following four categories: pretreatment operations, physical/chemical treatment processes, biological treatment, and post-treatment operations. Typical treatment process trains (combinations of unit operations) are presented for leachate containing organic and/or inorganic contaminants. Factors affecting leachate generation and its composition are addressed. Also discussed is the management of residuals--sludges, air emissions, concentrated liquid waste streams, spent carbon--generated by the various treatment techniques. (Lantz-PTT)
W90-03194

AQUIFER RESTORATION: STATE OF THE ART.
National Center for Ground Water Research, Norman, OK.
R. C. Knox, L. W. Canter, D. F. Kincannon, E. L. Stover, and C. H. Ward.
Pollution Technology Review No. 131. Noyes Publications, Park Ridge, New Jersey. 1986. 750p.

Descriptors: *Groundwater movement, *Aquifer restoration, *Groundwater pollution, *Cleanup operations, *Water pollution treatment, Water pollution control, Solidification, Capping, Grouting, Air stripping, Biological treatment, Chemical treatment, Chemical precipitation, Aquifers, Case studies.

The state-of-the-art of aquifer restoration is a rapidly changing technology, with many uses of single or combined techniques in the planning stage or recently implemented. Incidents of aquifer pollution from man's waste disposal activities have been discovered with increasing regularity. Until recently, the general viewpoint held by many groundwater professional and policy-makers was that once an aquifer had become polluted its water usage must be curtailed or possibly eliminated. However, this viewpoint is changing as a result of increasing needs for groundwater utilization and the development of appropriate methodologies for aquifer clean-up. The focus on methodologies has been heightened by current hazardous waste site clean-up efforts funded by 'Superfund'. The book includes sections on: groundwater pollution control through institutional measures, sources control, stabilization/solidification methods, well systems, interceptor systems, capping and liners, sheet piling, grouting and slurry walls; treatment of groundwater via air stripping, carbon adsorption, biological treatment, chemical precipitation, and other treatment techniques; in-situ chemical treatment and biological stabilization; a protocol for aquifer restoration decision-making; and techniques

for aiding the decision-making process. The appendices cover studies of aquifer restoration. (Lantz-PTT)
W90-03196

POISONED WELL: NEW STRATEGIES FOR GROUNDWATER PROTECTION.
Island Press, Washington, DC. 1989. 420p. Edited by Eric P. Jorgensen.

Descriptors: *Groundwater pollution, *Groundwater quality, *Water pollution control, *Regulations, *Legislation, Public participation, Groundwater pollution, Wells, Local governments, Political aspects, Federal jurisdiction, State jurisdiction.

Groundwater contamination is a national problem and the sources of potential groundwater contamination are everywhere. The challenge is to act to protect the groundwater we all need from the contamination sources in our communities. Congress is responding with new legislation, such as the Clean Water Act. This book is designed to help citizens to help themselves, based on the idea that the best way for citizens to protect their health is to go out and wage a fight against groundwater contamination. The book is split into four parts, each with a different purpose. Part I contains basic information about groundwater, how it is contaminated, how the public can be affected, and to find out whether groundwater is polluted. Part II describes in a general way how to use the laws. It explains how to obtain information from the government, how to work with administrative agencies, and how to use the courts. It also provides some basic advice about organizing and using nonlegal political tools as part of an overall strategy. Part III gives step-by-step advice about using specific federal programs, and Part IV summarizes state and local programs. (Lantz-PTT)
W90-03200

PREVENTION AND CLEANUP OF PETROLEUM CONTAMINATION OF GROUND WATER -- FLORIDA'S SUPER ACT.
Florida State Dept. of Environmental Regulation, Tallahassee.
C. Ash, C. Garrett, and S. Gray.
Florida Scientist FLSCAQ, Vol. 52, No. 4, p 225-229, Oct 1989. 4 ref.

Descriptors: *Water pollution prevention, *Oil pollution, *Florida, *Water pollution treatment, *Groundwater management, *Groundwater pollution, *Oil industry, *Petroleum products, *Cleanup operations, *Legislation, *Regulations, State jurisdiction, Public health, Preservation, Environmental protection.

In an effort to protect public drinking water supplies, the Florida Legislature enacted the 'State Underground Petroleum Environmental Response Act' of 1986 (SUPER Act). This bill created a trust fund which provides monies for the state to conduct site rehabilitation projects or for reimbursement to persons who have voluntarily or through negotiated enforcement cleaned up their sites. Participation in the program was encouraged by the establishment of a grace period (July 1, 1986-December 31, 1988) during which owners or operators of petroleum storage systems that reported suspected contamination were not held liable for the costs of restoring their sites. More than 9,000 applications were received during the 30 month grace period. Rules covering the order of site cleanup and reimbursement, establishing cleanup guidelines, and providing for reimbursement of reasonable costs have been adopted by the Environmental Regulation Commission. (Author's abstract)
W90-03215

STATUS OF SUPERFUND AND STATE-FUNDED CLEANUP SITES IN FLORIDA.
Florida State Dept. of Environmental Regulation, Tallahassee. Bureau of Waste Cleanup.
J. M. Ruddell.
Florida Scientist FLSCAQ, Vol. 52, No. 4, p 230-239, Oct 1989. 3 fig, 4 tab, 6 ref.

Descriptors: *Superfund, *Legal aspects, *Cleanup operations, *State jurisdiction, *Federal jurisdiction, *Florida, Groundwater pollution, Surface water pollution, Soil contamination, Adjudication procedure, Manpower, Environmental protection.

Of the 469 Florida sites with potential contamination identified as of May 1988, 39 are National Priorities List (NPL) sites and 23 are State Action sites--making them eligible for either the federal Superfund program or the state funded cleanup program. Thirteen of the Superfund sites are under state lead and 26 are managed by the U.S. Environmental Protection Agency (EPA). Forty one percent of Superfund sites are in the design or construction steps. Interim Remedial Measures (IRM) have been completed or are underway at 25 Superfund sites. Three of the Superfund sites have been proposed for deletion from the NPL--the cleanup completed or long term treatment installed and operating. Fifty two percent of the State Action Sites are in design or construction. IRM's have been completed or are underway at 7 State Action Sites. Remedial actions have been completed at 5 State Action Sites. Of the 407 remaining sites, 332 of them fall to responsible parties for further investigation and subsequent cleanup, and 75 require investigation. There are 262 sites with groundwater contamination, 144 with soil contamination, and 51 with surface water contamination. Since the Superfund and the state program were set up, procedures have been developed and refined. The rate of progress has picked up considerably in the last two to three years. Continued improvement in the programs will continue to increase allowing new sites to be addressed more quickly. There are two areas that will limit the rate of cleanup in the near future: (1) the time it takes to resolve legal issues, and (2) the availability of experienced professionals to carry out the programs and of laboratory capacity to do all of the work. (Author's abstract)
W90-03216

EMERGING LEGAL ISSUES IN GROUND-WATER CONTAMINATION CASES.
Huey, Guilday, Kuersteiner and Tucker, Tallahassee, FL.
For primary bibliographic entry see Field 2F.
W90-03243

PESTICIDES AND GROUND WATER PROTECTION.
Florida State Dept. of Environmental Regulation, Tallahassee. Bureau of Ground Water Protection.
C. C. Aller.
Florida Scientist FLSCAQ, Vol. 52, No. 3, p 221-224, Summer 1989. 7 ref.

Descriptors: *Environmental protection, *Groundwater pollution, *Water pollution prevention, *Florida, *Water quality control, *Pesticides, Water law, Ethylene dibromide, Drinking water, Monitoring, Water quality standards, Permits, Environmental effects, Nematodes, Soil contamination.

The development of the Department of Environmental Regulation (DER) pesticide program, based on a preventative strategy of groundwater protection, is reviewed. Chapter 17-3 of the DER has two important features: groundwater classification and water quality standards. The Chapter 17-3 standards for classification and water quality criteria are applied to groundwater discharges through permitting procedures which are contained in Chapter 17-4. With the passage of the Water Quality Assurance Act, the legislature provided positions in the department with scientific expertise to review the environmental effects of pesticides. Ethylene dibromide and other similar soil fumigants applied to control nematodes have impacted greatly on groundwater used as drinking water. The Pesticide Assessment Procedure was established to monitor the amount of such compounds reaching groundwater supplies. The state now supports remedial actions to control groundwater contamination incidents. (Geiger-PTT)
W90-03245

GROUND-WATER CONTAMINATION PROGRAMS OF THE U.S. GEOLOGICAL SURVEY IN FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
I. H. Kantrowitz.
Florida Scientist FLSCAQ, Vol. 52, No. 3, p 214-219, Summer 1989. 3 fig, 11 ref.

Descriptors: *Hydrologic data, *Data collections, *US Geological Survey, *Data acquisition, *Information exchange, *Groundwater pollution, *Groundwater management, *Florida, Water pollution prevention, Water quality management, Irrigation, Hazardous waste disposal, Landfills, Wastewater disposal, Saline water intrusion, Hydrologic data collections, Interagency cooperation.

The U.S. Geological Survey has the principal responsibility within the Federal Government of providing the hydrologic information and understanding needed to achieve the best use and management of the Nation's water resources. The Survey is involved in studies of groundwater contamination as part of its federally funded research program, in support of the programs of other Federal agencies, and in its cooperative water resources program with State and local agencies. Research investigations currently active in Florida include studies of groundwater contamination from agricultural practices, landfills, and hazardous waste sites, wastewater disposal, and seawater intrusion. These and other research activities, and the operation of an extensive data-collection network, provide much of the scientific basis for the groundwater management programs of about 70 State, regional, and local agencies in Florida. (Author's abstract)
W90-03246

AQUATIC WEED CONTROL.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
For primary bibliographic entry see Field 4A.
W90-03271

CORN YIELD AND RESIDUAL SOIL NITRATE AS AFFECTED BY TIME AND RATE OF NITROGEN APPLICATION.
Vermont Univ., Burlington. Dept. of Plant and Soil Science.
W. E. Jokel, and G. W. Randall.
Agronomy Journal AGJOAT, Vol. 81, No. 5, p 720-726, Sep/Oct 1989. 2 fig, 4 tab, 30 ref.

Descriptors: *Crop yield, *Nitrates, *Soil chemistry, *Water pollution prevention, *Fertilizers, *Nitrogen, *Corn, *Minnesota, Seasonal variation, Clays, Loam, Plant growth, Economic aspects, Environmental effects.

Efficient use of N fertilizer for corn production is important for increasing economic return to the grower and for minimizing the potential impact on water quality. Time and rate of application are important management tools for improving N efficiency. This experiment was conducted for 3 years on two nonirrigated southern Minnesota soils--a Mt. Carroll silt loam and a Webster clay loam--to evaluate the effect of time and rate of N application on corn yield, N uptake, and residual soil $NO_3(-)$-N. Nitrogen as $(NH_4)_2SO_4$ was applied in a factorial arrangement of N rate (Low and High) and time of application (at planting, eight-leaf stage, or split evenly between the two times). A zero N control and a very high N rate at planting were also included. Nitrogen rates were 75, 150, and 225 kg/ha on the Mt. Carroll, and 100, 200, and 300 kg/ha on the Wester. Grain and total dry matter yield, and plant uptake of N were increased by N application in five of six site years, in most cases up to the high N rate. Delayed N application resulted in either no effect or a slight decrease in dry matter and in variable effects on N uptake, depending on the year and location. Residual $NO_3(-)$-N in the 1.5 m profile ranged from 150 to 400 kg/ha for most treatments in the fall but was 50 to 70% lower the following spring. Residual $NO_3(-)$ in the fall was consistently increased by delayed application of the high N rate from the at

planting stage to the eight-leaf stage, with most of the increase occurring in the upper 0.6 m of the profile. The decrease in residual NO3(-) from fall to spring, attributed in part to leaching beyond the sampled zone, minimized the potential carryover effect for the next year's production and indicated a potential for greater environmental impact where N application was delayed. Dry matter production, N uptake, and residual NO3(-)-N were affected by unusually dry periods in midsummer of all 3 years, especially at the Webster site. (Author's abstract) W90-03282

STOCHASTIC SIMULATION MODEL OF OIL SPILL FATE AND TRANSFER.
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Water Resources and Environment Div.
For primary bibliographic entry see Field 5B.
W90-03320

FISHES IN THE ILLINOIS PORTION OF THE UPPER DES PLAINES RIVER.
Southern Illinois Univ., Carbondale. Dept. of Zoology.
For primary bibliographic entry see Field 5B.
W90-03385

COLUMBIA RIVER BASIN: EXPERIMENTING WITH SUSTAINABILITY.
Washington Univ., Seattle. Inst. for Environmental Studies.
K. N. Lee.
Environment ENVTAR, Vol. 31, No. 6, p 7-33, July/August 1989. 50 ref.

Descriptors: *Resources management, *Water resources development, *Multiobjective planning, *Fish management, *River basin development, *Columbia River, Policy making, Negotiation, Environmental policy, Planning, Regional planning, Electric power industry, Management planning, Stream fisheries.

Possible approaches for controlling the human impact upon the Columbia River basin area in the Pacific Northwest region are presented. After the native Americans, the second human civilization to invade the Columbia basin turned the river into a power plant, with numerous dams and hydroprojects. Just as the wilderness gave way to the power plant, so a new Columbia may arise, one whose watchword will be sustainable multiple use. This new Columbia is an ecosystem requiring active management. To achieve sustainability, humans must somehow pick a path between preservation and profit maximization. In 1980, the Northwest Power Act was passed to mitigate the effects of half a century of hydroelectric power development. The Northwest Power Planning Council was created by the Act for three purposes: to formulate a long-range power plan for the Pacific Northwest; to develop a program to rebuild the fish and wildlife populations of the Columbia; and to involve the public in decisions on energy and fish and wildlife. Work in progress encompasses salmon harvesting, enhanced fish production and improvement of natural spawning habitats. Budgeting for fish, and a general strategy devised to deal with natural resources called adaptive management, are also being implemented. Adaptive management responds to biological uncertainty, but it is not clear how the adaptive approach can work in the presence of institutional complexity. This is where consensus building is important. The challenge of a sustainable Columbia River is no different from the challenge of sustainable development generally and involves complex problems and uncertainty. (VerNooy-PTT)
W90-03442

AWWA LEAD INFORMATION SURVEY: A FINAL REPORT.
Black and Veatch, Kansas City, MO.
M. M. Fry.
Journal of the American Water Works Association JAWWA5, Vol. 81, No. 9, p 64-68, September 1989. 7 fig, 3 tab, 5 ref.

Descriptors: *Lead, *Water distribution, *Monitoring, *Surveys, Regulations, Path of pollutants, Heavy metals.

In June 1987 AWWA surveyed utility members who had initiated preliminary monitoring for lead in their distribution systems in anticipation of federal regulatory action on lead. The Lead Information Survey (LIS) requested information on water quality, current corrosion control treatment practices, and results of any preliminary monitoring conducted up to that date. This article presents overall trends indicated by the LIS regarding compliance capabilities of large water suppliers to meet lead-control requirements proposed in 1988 by the US Environmental Protection Agency (USEPA). In addition, corrosion control practices of the industry are reviewed. It is important to note that the data were collected prior to the proposed lead rule and that the survey provides only a limited glimpse of the total water industry. As more information becomes available on the ability of corrosion control measures to affect lead levels in drinking water, the validity of the trends outlined in this article should be revaluated. (Author's abstract)
W90-03469

ORGANIC MATTER TRANSPORT AND RETENTION IN A BLACKWATER STREAM RECOVERING FROM FLOW AUGMENTATION AND THERMAL DISCHARGE.
Montana Univ., Polson. Flathead Lake Biological Station.
F. R. Hauer.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 4, p. 371-380, November-December 1989. 6 fig, 1 tab, 35 ref. DOE contract DE-AC09-76SR00819.

Descriptors: *Water quality, *Thermal pollution, *Flow augmentation, *Cooling water, *Nuclear powerplants, Benthic environment, Detritus, Debris dams, Organic matter, Stream improvement, Channel morphology, Seston.

Organic and inorganic seston, benthic organic matter and woody debris were studied in a blackwater stream/floodplain system recovering from flow augmentation and thermal discharges. The study was conducted from March 1983 to April 1984 on two second order tributaries in the sandhill of the Aiken Plateau of South Carolina: Steel Creek and its major tributary stream, Meyer's branch. The stream had received cooling waters from two nuclear reactors from the mid-1950s to 1968, resulting in flows over 10x greater than normal and temperatures that exceeded 70 degrees C. Channel morphology was markedly altered, woody debris was removed or buried, and floodplain vegetation was destroyed. Fifteen years after termination of cooling water discharges, the stream continued to exhibit many characteristics of a disturbed system. Compared to an undisturbed reference stream, the recovering stream had substantially less benthic organic matter, fewer snags and debris dams, and transported more organic and inorganic seston of all size fractions examined. Because of the importance of these biophysical factors in the structural morphology of blackwater streams, it is hypothesized that complete recovery will not be realized until the floodplain forest has matured and large woody debris is contributed to the stream channel. (Author's abstract)
W90-03510

STUDY AND RECOMMENDATIONS ON THE SAN GERMAN VAULTED BRICK TUNNEL STORM SEWER SYSTEM.
Puerto Rico Univ., Mayaguez. Dept. of General Engineering.
L. Pumarada-O'Neill, and M. Cruz-Arocho.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109372/AS, price codes: A06 in paper copy, A01 in microfiche. Final Technical Report, Puerto Rico Water Resources Research Institute, Mayaguez, July 1988. 109p, 5 fig, 3 tab, 17 ref, 2 append. USGS Contract 14-08-0001-G-1446. USGS Project G1446-05.

Descriptors: *Storm sewers, *Storm wastewater, *Storm drains, *Tunnel hydraulics, Urban drainage, Puerto Rico, San German, Subsurface drains, Tunnels, Tunnel systems, Tunnel inspection.

A vaulted brick storm sewer system of uncertain origin, which in the past has suffered partial collapse, is still in use under the city of San German. This project intended to establish its route, structural integrity, future adequacy and tourism potential. The system's main tunnel was photographed, reconnoitered, surveyed and drawn. Visual inspections and dye tests located the limits of the drainage basin. A 24-hour composite sample of stream water was analyzed for pollutants. The city archives were searched for historical records and knowledgable persons were interviewed. The main tunnel conducts a permanent stream called Quebrada Manzanares, whose channel was enclosed segment by segment, haphazardly, between 1835 and 1915. This tunnel needs a service access, repair of its leaking damaged floors, and removal of raw sewage discharges. At present parts of the system threaten collapse, which would affect flood control and neighboring streets and buildings. The development of its great tourism potential is hindered by the problems of flash floods during storm events and polluted water due to illegal discharges of raw sewage. (Pumarada-O'Neill-U. Puerto Rico, Mayaguez)
W90-03555

CHEMICAL MODELING OF A DAIRY WASTE/WATER MANAGEMENT, POLLUTION CONTROL SYSTEM FOR FARM MANAGEMENT IN PUERTO RICO.
Puerto Rico Univ., Mayaguez. Dept. of Chemistry.
R. Butler, and Y. Shahabasi.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-107020/AS, price codes: A04 in paper copy, A01 in microfiche. Final Technical Report, Puerto Rico Water Resources Research Institute, Mayaguez, June 1986. 50p, 6 fig, 15 tab, 10 ref. USGS Contract 14-08-0001-G1041. USGS Project G1041-06.

Descriptors: *Model studies, *Chemical models, *Waste management, *Pollutant identification, *Wastewater treatment, *Wastewater lagoons, Farm wastes, Animal wastes, Water pollution control, Manure, Water reuse, Methane, Wastewater disposal, Ion-selective electrodes, Spectroscopy.

This project involved the establishment of a chemical model of a waste management system on a small dairy farm, with the intention that such a model could be used as a basis for evaluation and optimization of the system. The system used involved water flushing of dairy animal wastes into a temporary holding tank in which the diluted wastes are chopped and homogenized. The homogenized slurry is then pumped either to a large anaerobic lagoon, where microbial degradation of organic and inorganic components takes place or for the charging of an anaerobic digestion tank for the production of methane gas. The methane gas can then be used as a fuel for electricity production. Lagoon water is then used for field irrigation. This project involved the measurement of the inorganic species nitrate, potassium, calcium, magnesium, and sodium at the influx to the holding tank, the holding tank, the influx to the lagoon and in the lagoon. Emphasis was placed on the development of the most appropriate analytical techniques for obtaining species data which would allow the evaluation of the system from the pollution abatement and cost recovery points of view. Results demonstrate the utility of ion selective electrodes and atomic spectroscopy (flame emission and atomic absorption) for such analyses and indicate that in some cases the measurement of low levels of nitrogen species (nitrate, nitrite, ammonium) by automated colorimetric techniques is probably more suitable, although this would require treatment of samples from the first two stages of the system to remove colored impurities. The anaerobic lagoon system shows great promise from the point of view of organic matter and nutrient degradation (i.e. pollution control), without those disadvantages encountered in more temperate climates. This is obtained, however, with the loss of most of the nitrogen fertilizer value of the wastes. (Butler-Puerto Rico WRRI)

W90-03559

PLANNING MODEL FOR THE CONTROL AND TREATMENT OF STORMWATER RUNOFF THROUGH DETENTION STORAGE.
Puerto Rico Univ., Mayaguez. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-03561

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

WATER-QUALITY MANAGEMENT THROUGH COMBINED SIMULATION-OPTIMIZATION APPROACH.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W90-02723

CONTRACT OPERATIONS: ONE YEAR LATER.
For primary bibliographic entry see Field 5D.
W90-02736

BASIC PRINCIPLES OF THE ORGANIZATION OF SYSTEMS PROVIDING RELIABILITY AND QUALITY CONTROL OF THE CONSTRUCTION OF HIGH EARTH DAMS.
For primary bibliographic entry see Field 8A.
W90-03247

CONSENSUS BUILDING IN TODAY'S ENVIRONMENTALLY CONSCIOUS SOCIETY.
J. L. McNelly.
Journal of the New England Water Works Association JNEWA6, Vol. 103, No. 3, p 156-159, November 1989.

Descriptors: *Public participation, *Water resources development, *Water management, *Resource allocation, *Water permits, *Decision making, *Political aspects, *Legislation, Consensus building.

Conflicts over the allocation and management of water resources are becoming more commonplace and increasingly difficult to resolve. On the one hand there is the continually increasing demand for water as populations expand and lifestyles increase the per capita consumption of the resource. On the other hand the rapid rate of technological development has created an increased awareness and greater public involvement in matters that deal with natural resources. This increased awareness does not always mean that individuals have a greater knowledge of the issue but it does certainly increase the complexity of the situation. Efforts to develop water sources are often viewed cautiously by the general public, and various individuals, agencies and other entities inevitably become involved in the approval process that is part of bringing a new source on line. Perhaps the best method to use in deciding the fate of water resource allocation issues is Decision by Consensus. While this is the most time-consuming method, all parties in the group feel that they have had a fair chance to influence the decision. Consensus building allows the parties to become part of the process, rather than being a victim of the process. An example of the utility of the consensus building technique involves the attempts of a local water company to utilize two ponds to which it had been granted water rights by the Maine legislature. The ensuing struggle between the water company, the town, the various state and local regulatory and permitting agencies, environmental organizations, and the local lake associations presented obstacles in the form of intervention during the environmental permitting process, refusal of the town to grant a building permit for a pump station, and the introduction of three different legislative bills to rescind the water company's rights

to the ponds. Although the issues were not easily resolved, the water company, through consensus building, has succeeded in obtaining some of the necessary approvals. (Sand-PTT)
W90-03404

METHODOLOGIES AND STEPS ASSOCIATED WITH DEVELOPING A PUBLIC WATER WELL.
Maher (D.L.), Inc., North Reading, MA.
For primary bibliographic entry see Field 5F.
W90-03406

COLUMBIA RIVER BASIN: EXPERIMENTING WITH SUSTAINABILITY.
Washington Univ., Seattle. Inst. for Environmental Studies.
For primary bibliographic entry see Field 5G.
W90-03442

OPTIMAL REAL-TIME FORECASTING AND CONTROL OF RESERVOIR HYDROSYSTEMS USING REMOTE AND ON-SITE SENSORS, VOLUME I: FORECASTING RESERVOIR INFLOWS.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2A.
W90-03552

OPTIMAL REAL-TIME FORECASTING AND CONTROL OF RESERVOIR HYDROSYSTEMS USING REMOTE AND ON-SITE SENSORS, VOLUME II: RESERVOIR CONTROL.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 2A.
W90-03553

6B. Evaluation Process

WHAT HAPPENED TWENTY YEARS AFTER THE GRANDE MOTTE MARINA BUILDING ENDED (LA GRANDE MOTTE, VINGT ANS APRES).
Laboratoire National d'Hydraulique, Chatou (France).
R. Bonnefille, and F. Rueda.
Houille Blanche HOBLAB, Vol. 1989, No. 5, p 387-398, 1989. 12 fig, 2 ref. English summary.

Descriptors: *Marinas, *Coastal zone management, *Model studies, Littoral drift, On-site tests, Groins, Breakwaters, France.

In 1963, the Grande Motte marina study began with a scale model built at Sete, France near the site. The main conclusion of the study was that the designed harbor would not suffer serious problems due to littoral sand transport. More than twenty years after the harbor has been built, it appeared useful to compare the model predictions and the on-site observed events. The study was successful as far as sediment movement is concerned; some imperfections in detail behavior of the scale model are instructive. The coastal protection built on the eastern side of the harbor, with one groin and three breakwaters, is also described. (Author's abstract)
W90-02555

ECONOMICS OF DAM FAILURE: ANOTHER LOOK AT CATASTROPHIC LOSSES.
Colorado State Univ., Fort Collins. Dept. of Economics.
For primary bibliographic entry see Field 6C.
W90-02582

SELECTION OF RECEPTOR SITES FOR OPTIMIZED ACID RAIN CONTROL STRATEGIES.
Texas A and M Univ., College Station. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W90-02724

SOCIAL IMPACT AND RECREATIONAL USE OF INLAND WATER RESERVOIRS IN PUERTO RICO.
Puerto Rico Univ., Mayaguez. Dept. of Social Sciences.
O. N. Hernandez, and J. Gutierrez-Sanchez.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109414/AS, price codes: A04 in paper copy, A01 in microfiche. Final Technical Report, Puerto Rico Water Resources Research Institute, Mayaguez, June 1987. 48p, 7 fig, 13 tab, 15 ref, append.

Descriptors: *Recreation demand, *Puerto Rico, *Lakes, *Social impact, *Demographic surveys, Recreation, Reservoir sites, Recreation facilities, Socioeconomic aspects, Attitudes, Social behavior, Planning, Management.

This report describes the characteristics and leisure behavior of visitors engaged in recreational activities at Puerto Rico lakes: Guajataca, La Plata, Dos Bocas, and Luchetti. Description of lake facilities and local residents opinions about the lake area are also included. Lakes, in this case, are dams built as water reservoirs for either domestic water supply or energy generation. Recreation is assumed as a legitimate secondary activity that should be promoted. Data were obtained mainly through a survey of lake visitors and supplemented by field observations. Data were collected between June 1986 and March 1987. The information gathered establishes a profile of demographic and socioeconomic characteristics of lake users, provides knowledge of recreational activity along the lakes and gives direction to agencies responsible for the planning and management of lakes in Puerto Rico. (Hernandez-Puerto Rico, WRRI)
W90-03546

STUDY AND RECOMMENDATIONS ON THE SAN GERMAN VAULTED BRICK TUNNEL STORM SEWER SYSTEM.
Puerto Rico Univ., Mayaguez. Dept. of General Engineering.
For primary bibliographic entry see Field 5G.
W90-03555

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

ECONOMICS OF DAM FAILURE: ANOTHER LOOK AT CATASTROPHIC LOSSES.
Colorado State Univ., Fort Collins. Dept. of Economics.
H. Cochrane.
Water Resources Research WRERAQ, Vol. 25, No. 9, p 1931-1935, September 1989. 1 tab, 8 ref.

Descriptors: *Dam failure, *Cost analysis, *Risk assessment, *Flood plain management, *Economic aspects, Flood damage, Costs, Dams, Structure, Population exposure, Capital costs, Benefits, Flood control, Land appraisals, Land management.

The analytical framework for evaluating the effects of dam failure on capital located in the flood plain needs to incorporate the risk of catastrophic failure into the risk cost analysis for new and existing high-hazard dams. By including both losses to structures and lost flood control benefits, the current method of computing risk costs introduces some measure of double counting; if the dam fails, the postevent population at risk, the number of residences, and the public capital in the flood plain would be identical to that which existed prior to the collapse. In the event that the capital stock surviving the failure proves to be negligible, lost flood control benefits may be equally negligible. The word 'may' must be emphasized since it is not clear whether rebuilding will always be effectively controlled, or whether the net loss of land value will prove to be insignificant for the majority of events. At a minimum, risk-cost methods will have to be broadened to reflect these issues. (Fish-PTT)
W90-02582

MANCHESTER WATER WORKS' SOURCE DEVELOPMENT CHARGE.
McLane, Graf, Raulerson and Middleton, Manchester, NH.
R. A. Samuels.
Journal of the New England Water Works Association JNEWA6, Vol. 103, No. 3, p 160-164, November 1989.

Descriptors: *Water supply development, *Municipal water, *Water demand, *Capital costs, *Construction costs, *Water costs, *User charges, Manchester, New Hampshire, Merrimack River, Lake Massabecic.

A 1985 study of the water resources of the Manchester, Hew Hampshire, Water Works, concluded that Lake Massabesic, Manchester Water Works' reservoir, had adequate capacity to serve the City and the franchised areas within the surrounding towns well into the 21st century, but that the supply was inadequate for service to additional areas in the towns surrounding Manchester. The study concluded that the flow in the Merrimack River was more than adequate to meet the demand that was anticipated to come from areas within the surrounding towns to which the Water Works would extend its service in the future. The New Hampshire Water Supply and Pollution Control Division gave approval to divert water from the Merrimack to Lake Massabesic. Most of the system development charges were charges made to all new customers, in all areas, and were normally justified as a system buy-in and calculated on that basis. The Manchester Water Works' source development charge is designed to be paid only by those customers added within newly franchised areas, consistent with the determination by the Water Works that Lake Massabesic provided adequate supply for the City and existing franchised area. The source development charge was not a system buy-in but a charge that would constitute a customer's capital contribution to a proportionate share of the Merrimack River water supply project. The charge was based on the product of estimated usage in gallons per day and estimated cost per gallon per day of the project. The project would be fully and exclusively funded through the source development charge, but the cost of the project included interest payments on funds that the Water Works would borrow under the City's general obligation bonding. Funds would be borrowed only to the extent that costs, because of the construction schedule, significantly exceeded charge proceeds at any point in time. (Sand-PTT)
W90-03405

6D. Water Demand

EFFECTS OF BOREHOLE WELLS ON WATER UTILIZATION IN SCHISTOSOMA HAEMATOBIUM ENDEMIC COMMUNITIES IN COAST PROVINCE, KENYA.
Cornell Univ., Ithaca, NY.
For primary bibliographic entry see Field 5F.
W90-02652

CHARACTERISTICS OF OHIO'S LAKE ERIE RECREATIONAL MARINAS.
Ohio Cooperative Extension Service, Painesville.
F. R. Lichtkoppler, and L. J. Hushak.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 3, p 418-426, 1989. 8 tab, 7 ref.

Descriptors: *Lake Erie, *Marinas, *Recreation, *Boating, Recreation demand, Recreation facilities, Ohio, Economic aspects.

The number of marinas identified on Ohio's north coast has increased from 237 in 1979 to 383 in 1986. From 1979 to 1986 there was a shift of 7% of the firms from the one to two million dollar sales group to the over two million dollar sales group. The typical respondent marina opened in summer 1960, had operated under the current management for 18.4 years, and grossed an estimated $893,875 in annual sales. This typical marina employed 5.5 people year-round full-time. An additional 4.4 full-time and 3.0 part-time people worked during the 6.6 months the average marina was open. Eighty-

seven percent of respondents offered boat docks for lease and averaged almost 105 docks per respondent. Approximately 80% of the responding marinas had made capital improvements to their facilities in the past 5 years. In-the-water boat dockage was leased out at a 96.6% rate of capacity, and almost two-thirds of the responding marinas had waiting lists of customers who wished to lease the boat docks. In general, more marinas under new management (mean 5.5 years) have made improvements in their facilities and plan to expand their facilities than marinas under old management (mean 34.3 years). This work provides a description of the characteristics of Ohio's Lake Erie marina industry that will be useful in assisting researchers, marina developers, public officials and others to better understand the industry. (Author's abstract)
W90-02748

IRRIGATION EFFECTS ON WATER USE, AND PRODUCTION OF TAP ROOTS AND STARCH OF BUFFALO GOURD.
Maricopa Agricultural Center, AZ. Dept. of Plant Science.
For primary bibliographic entry see Field 3F.
W90-02829

CONSTRAINED MEDIAN STATISTICAL ROUTING METHOD AND THE PECOS RIVER CASE.
Texas Univ. at Austin. Center for Cybernetic Studies.
A. Charnes, R. Dickinson, J. Heaney, and S. Duffuaa.
Applied Mathematical Modelling AMMODL, Vol. 13, No. 6, p 330-338, June 1989. 3 fig, 1 tab, 11 ref.

Descriptors: *Routing, *Flood routing, *Model studies, *Streamflow forecasting, *New Mexico, *Texas, *Mathematical models, *Water rights, *River flow, Riparian waters, Statistical methods, Water use, Water resources development, Computer models.

A river routing is a mathematical abstraction of a river which numerically estimates the availability of water in the river at given points and times under specified or assumed conditions. The routing model estimates all gains and depletions on the river in all reaches. The depletions result from such items as reservoir evaporation, channel losses, irrigation diversions, and domestic and industrial water usages. Gains are from such items as river tributaries, flood inflows, and underground contributions. In general, all natural and man-made activities are considered in a routing study. A mathematical model of constrained nonlinear form for river routing has been developed. The data recorded at the gauges are usually estimates of the actual flow. Thus the model automatically makes best-fit adjustments for this data so as to preserve physical and hydrological conditions on the river basin. The best fit is accomplished by minimizing a heavily penalized sum of absolute deviations between the recorded and the adjusted data. The model simultaneously estimates new losses, reservoir storage, spill, and flood inflows. The new estimates conform to physical and hydrological conditions, such as mass balance. The model was applied to the legal dispute between Texas and New Mexico over the water of the Pecos River. The objective was to determine New Mexico's obligation for water deliveries at the Texas-New Mexico border. The model was also compared to previous studies performed on the river. The results show that a substantial amount of water is owed to Texas. On the average the water owed to Texas per year is 282,000 acre-feet. This is above the amount proposed by New Mexico by 60,000 acre-feet. This model could be employed in estimating water allocations on the Nile River and cash and labor flow between countries. (Author's abstract)
W90-03321

CONSENSUS BUILDING IN TODAY'S ENVIRONMENTALLY CONSCIOUS SOCIETY.
For primary bibliographic entry see Field 6A.
W90-03404

SOCIAL IMPACT AND RECREATIONAL USE OF INLAND WATER RESERVOIRS IN PUERTO RICO.
Puerto Rico Univ., Mayaguez. Dept. of Social Sciences.
For primary bibliographic entry see Field 6B.
W90-03546

6E. Water Law and Institutions

KILLING THE RHINE: IMMORAL, BUT IS IT ILLEGAL.
A. H. Darrell.
Virginia Journal of International Law, Vol. 29, No. 2, p 421-472, Winter 1988.

Descriptors: *Rhine River, *Legal aspects, *Water pollution control, *International law, Political constraints, Jurisdiction, Water pollution, Switzerland, Law enforcement.

The causes and consequences of the Basel chemical fire which resulted in toxic chemicals entering the Rhine River are outlined along with the development of international law as it relates to transnational environmental pollution. Public international pollution law comes into play when a state is accused by another state either of an illegal act or of the omission of a duty or obligation. International law provides no clear rules regarding state responsibility for environmental damage. States, including Switzerland, are generally unwilling to bring charges against each other in the fear of establishing precedent that may one day be used against them. Cases of international pollution tend not to end up in formal international courts; rather, they are dealt with either through direct bilateral diplomatic correspondence, private suits or careful sweeping under the rug. For these reasons, Rhine pollution has been only minimally reduced and regulated despite several treaties. Swiss actions show a reluctant acceptance of the customary concept of limited sovereignty and a carefully choreographed avoidance of any nonretractable statement about obligations due its neighbors. The Basel fire has highlighted the weaknesses of the international law of transboundary pollution and has laid bare leadership and communications problems inconsistent with plans to decrease the role of borders in European intercourse. For legal progress to be made, governments must be convinced of the need for increased ecologically conscious oversight of industrial production. International law can provide a framework for communication and value articulation and determine obligations. Perhaps most importantly, a source of funding for international clean-up activities needs to be created, possibly functioning as an international insurance agency funded in part by states and in part by polluting corporations. (White-Reimer-PTT)
W90-02704

CONSUMPTION ADVISORIES FOR SPORT FISH IN THE GREAT LAKES BASIN: JURISDICTIONAL INCONSISTENCIES.
National Wildlife Federation, Ann Arbor, MI. Great Lakes Natural Resource Center.
J. A. Foran, and D. VanderPloeg.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 3, p 476-485, 1989. 2 fig, 3 tab, 8 ref.

Descriptors: *Water pollution, *Pollutant identification, *Great Lakes, *Sport fishing, *Regulations, *Public health, State jurisdiction, Contamination, Consumption, Methods, Toxicity.

Consumption advisories for contaminated sport fish in the Great Lakes are developed by states using a variety of methods and trigger levels. The methods and trigger levels used by the Great Lakes states to develop consumption advisories were examined, and consumption advice resulting from the use of these methods compared for the U.S. waters of the Great Lakes. The methods used to develop consumption advice vary widely between and among lakes. The result of the use of different methods is development of different consumption advice for fish with similar types and quantities of contaminants. The degree of stringency of advice also varies depending on the types

and quantities of contaminants in fish tissue. Different advice and stringency can only serve to confuse the fishing public and those consuming Great Lakes sport fish, and ultimately may result in consumption advice being ignored entirely. It is suggested that the Great Lakes states have not yet met the mandate or the spirit of the Governors' 1986 Toxic Substances Control Agreement for development of uniform consumption advisories for sport fish. The adoption of a uniform method for development of fish consumption advisories for all of the Great Lakes and application of the method to all fish that are contaminated with toxic organic and inorganic substances is recommended. (Author's abstract)
W90-02754

GROUND-WATER PROTECTION IN THE UNITED STATES.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 5G.
W90-03169

NUCLEAR GROUNDWATER PROTECTION.
Bergakademie Freiberg (German D.R.). Dept. of Geosciences.
For primary bibliographic entry see Field 5G.
W90-03170

POISONED WELL: NEW STRATEGIES FOR GROUNDWATER PROTECTION.
For primary bibliographic entry see Field 5G.
W90-03200

PREVENTION AND CLEANUP OF PETROLEUM CONTAMINATION OF GROUND WATER -- FLORIDA'S SUPER ACT.
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5G.
W90-03215

STATUS OF SUPERFUND AND STATE-FUNDED CLEANUP SITES IN FLORIDA.
Florida State Dept. of Environmental Regulation, Tallahassee. Bureau of Waste Cleanup.
For primary bibliographic entry see Field 5G.
W90-03216

PESTICIDES AND GROUND WATER PROTECTION.
Florida State Dept. of Environmental Regulation, Tallahassee. Bureau of Ground Water Protection.
For primary bibliographic entry see Field 5G.
W90-03245

CRITICAL LOOK AT WYOMING WATER LAW.
Wyoming Univ., Laramie. Coll. of Law.
M. Squillace.
Land and Water Law Review LWLRDC, Vol. 24, No. 2, p 307-346, 1989. 1 fig, 259 ref.

Descriptors: *Wyoming, *Water rights, *Water law, Legal aspects, Water allocation, Water transfer.

From its earliest history Wyoming has used the prior appropriation doctrine to allocate water rights. Over time, Wyoming water law has evolved to accommodate changing needs and values, but the basic scheme established by the first state legislature for allocating water rights remains intact. The Wyoming constitution establishes a Board of Control, which together with the State Engineer administers water rights in the state. The Wyoming constitution calls for a State Engineer, who is qualified by theoretical knowledge and practical experience, to be appointed by the Governor and confirmed by the state senate for a six-year term. Wyoming hosts a variety of public and private water distribution organizations. The most common organizations are mutual ditch companies, irrigation districts, and water conservancy districts. Wyoming water rights are subject to the right of the public to float on the surface of water

bodies for recreational purposes. Legislation passed in 1986 allows the state to acquire rights to instream flows to establish or maintain fisheries. Under Wyoming law, preferred uses of water include (1) drinking water; (2) water for municipal purposes; (3) water for the use of steam engines and general railway use; water for culinary, laundry, bathing, refridgerating, steam and hot water heating plants, and steam power plants; and (4) water for industrial purposes. Surplus and excess water statutes were enacted in response to concerns among Wyoming farmers that additional water resources were needed to compensate for the short growing season that exists in many parts of the state. Each of the four water divisions of the state has a division advisory committee appointed by the Governor which advises the Board of Control and the State Engineer on groundwater problems in their division. (Mertz-PTT)
W90-03368

WATER LAW--THE UNITED STATES SUPREME COURT EXPANDS THE PUBLIC TRUST DOCTRINE. PHILLIPS PETROLEUM CO. V. MISSISSIPPI, 108 S. CT. 791 (1988).
D. J. Gardner.
Land and Water Law Review LWLRDC, Vol. 24, No. 2 p 347-356, 1989. 93 ref.

Descriptors: *Water law, *Mississippi, *Submerged lands, *Public trust doctrine, Navigable waters, Judicial decisions, Legal aspects.

In Phillips Petroleum Co. v. Mississippi, the Supreme Court included discrete water, influenced by the ebb and flow of the tide, within the scope of the public trust doctrine. Before 1977, Phillips Petroleum held an undisputed title to 42 acres of land in southwestern Mississippi. The land beneath 11 drainage streams which flowed into the Gulf of Mexico several miles from the disputed land. In 1977, the State of Mississippi claimed title to the land under the public trust doctrine and issued leases for oil and gas exploration. This casenote analyzes the history and purpose of the public trust doctrine and concludes that the Court's holding expanded the ebb and flow distinction beyond its reasonable scope. The purpose of the public trust doctrine was to allow states to maintain public access to water capable of supporting navigation. The Court should have determined title to the submerged land according to the water's ability to transport commerce as established in previous Court decisions. The Court's departure from precedent inequitably divested Phillip's title to the land. The Court held that reasonable property expectations along the coast were not disrupted. However, under Phillips, any property owner near the coast with reasonable property expectations may lose property rights. The purpose of the public trust doctrine and the inequitable result in Phillips do not support the Courts's expansion of the doctrine. (Mertz-PTT)
W90-03369

CONSENSUS BUILDING IN TODAY'S ENVIRONMENTALLY CONSCIOUS SOCIETY.
For primary bibliographic entry see Field 6A.
W90-03404

COLUMBIA RIVER BASIN: EXPERIMENTING WITH SUSTAINABILITY.
Washington Univ., Seattle. Inst. for Environmental Studies.
For primary bibliographic entry see Field 5G.
W90-03442

6F. Nonstructural Alternatives

FLOOD CONTROL EXPERIENCE IN THE USA.
A. B. Avakyan, and A. A. Polyushkin.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 1, p 53-58, July 1989. 2 fig, 9 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, p 50-53, January 1989.

Descriptors: *Flood control, *Flood plain management, *Disasters, *Cost repayment, Economic as-

pects, Recreation facilities, Insurance, Reservoirs, Urban planning, Flood protection, Flood forecasting.

Floods in the U.S. are one of the most hazardous and destructive natural disasters. The loss caused by floods is divided into direct and indirect. Direct loss includes that related to actual physical destruction. Indirect loss is divided into two categories: (1) losses which can be estimated, and (2) losses which can only difficultly be expressed in terms of money only with difficulty. The main causes of the increase of losses from floods are: an increase in the economic use of territories subjected to periodic inundation by floods and freshets; expansion of the recreation zones in such regions; increase of expenditures on insurance claims and restoration works. Among the engineering measures of flood control the main role is played by the creation of reservoirs. In the U.S. considerable importance is attached to flood protection of urbanized territories. The general trends characteristic of flood control in the U.S. began on a wide scale in the middle of the first half of the twentieth century. Since the end of the 1960s considerable attention has been devoted to the organization of the collection of information about floods, their forecasting, and notification in case of the threat of a flood. Now the U.S. has the best flood forecasting system among many other countries. (Fish-PTT)
W90-02564

6G. Ecologic Impact Of Water Development

CONSEQUENCES OF SEA LEVEL RISE: IMPLICATIONS FROM THE MISSISSIPPI DELTA.
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 2L.
W90-02552

EFFECTS OF IRRIGATED AGRICULTURE ON GROUNDWATER QUALITY IN CORN BELT AND LAKE STATES.
Fuller, Mossbarger, Scott and May, Lexington, KY.
For primary bibliographic entry see Field 3E.
W90-02569

IRRIGATED AGRICULTURE AND WATER QUALITY IN SOUTH.
Maryland Univ., College Park. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W90-02570

IRRIGATED AGRICULTURE AND WATER QUALITY IN EAST.
Delaware Univ., Newark. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W90-02571

IRRIGATION IMPACT ON GROUNDWATER: MODEL STUDY IN HUMID REGION.
Agricultural Research Service, Tifton, GA. Southeast Watershed Research Center.
For primary bibliographic entry see Field 5B.
W90-02572

PREDICTION OF REWORKING OF THE BANKS OF LOWER RESERVOIRS OF PUMPED-STORAGE STATIONS.
For primary bibliographic entry see Field 2J.
W90-02693

REFINED MODEL OF THE EFFECT OF A RESERVOIR ON ROCK FOUNDATIONS OF HIGH DAMS.
For primary bibliographic entry see Field 8A.
W90-02702

KILLING THE RHINE: IMMORAL, BUT IS IT ILLEGAL.
For primary bibliographic entry see Field 6E.
W90-02704

HYDRAULIC MODELLING OF TIDAL CIRCULATION AND FLUSHING IN COASTAL BASINS.
Washington Univ., Seattle.
R. E. Nece, and R. A. Falconer.
Proceedings of the Institution of Civil Engineers PCIEAT, Vol. 86, Pt. 1, p 913-935, Oct 1989. 11 fig, 3 tab, 15 ref.

Descriptors: *Hydraulic models, *Model studies, *Mathematical models, *Coastal waters, *Coastal zone management, Harbors, Marinas, Physical models, England, Washington, Environmental protection.

The increasing concern of planners and designers for the hydroenvironmental problems relating to tidal circulation and flushing in small coastal basins, harbors, and marinas, and the use of physical and mathematical models as design tools to address such problems are summarized. Details are given of techniques frequently adopted in using both physical and mathematical models to quantify tidal flow patterns and water exchange characteristics of harbors and marinas. Emphasis is placed on comparative studies where alternative basin geometries and/or bathymetries are proposed. An example application of each approach is presented using the tidal flushing behavior of the proposed Harbour Pointe Marina on Puget Sound for the physical model, and the investigation of the impact of a land reclamation proposal and embankment bridge design on the tidal flow and flushing characteristics in Holes Bay, Dorset for the mathematical model. The selection of the type of model to use for a particular project must be based on criteria of technical appropriateness as well as of cost. Physical models are appropriate for small-scale projects such as marinas where mathematical model verification is generally not possible because the water bodies have not yet been constructed. Mathematical models become more feasible and appropriate when the water body under investigation is larger, fine grid scale knowledge of the flow field is not so important, and where there is a better chance of obtaining field data for model verification. The cost of physical models varies with the scale of the prototype project, whereas the cost of a mathematical model tends to be more independent of project size. (White-Reimer-PTT)
W90-02807

COASTAL LAGOONS OF BRITAIN: AN OVERVIEW AND CONSERVATION APPRAISAL.
Cambridge Univ. (England). Dept. of Zoology.
For primary bibliographic entry see Field 2L.
W90-02810

CAN WATER LOSSES FROM RESERVOIRS IN KARST BE PREDICTED.
Karlova Univ., Prague (Czechoslovakia). Dept. of Hydrogeology and Engineering Geology.
For primary bibliographic entry see Field 2F.
W90-03179

DESIGN AND ANALYSIS METHODS FOR FISH SURVIVAL EXPERIMENTS BASED ON RELEASE-RECAPTURE.
North Carolina State Univ. at Raleigh. Dept. of Statistics.
For primary bibliographic entry see Field 7B.
W90-03197

PRACTITIONER'S HANDBOOK ON THE MODELLING OF DYNAMIC CHANGE IN ECOSYSTEMS.
Institute of Terrestrial Ecology, Grange over Sands (England). Merlewood Research Station.
J. N. R. Jeffers.
Scientific Committee on Problems of the Environment of the International Council of Scientific Unions No. 34. John Wiley and Sons, New York, NY. 1988. 181p.

Descriptors: *Limnology, *Ecology, *Environmental effects, *Ecosystems, *Model studies, *Succession, *Handbooks, Population dynamics, Ecology, Statistical models.

This handbook outlines the techniques available to scientists who wish to model dynamic change in ecosystems, either those traditionally used for agriculture, or natural systems which are being destabilized by human intervention. It was prepared in response to one of the specific recommendations of the Santa Barbara (CA) workshop (January 12-16, 1976), which called for the preparation of a practitioner's manual to outline the techniques necessary for the modelling of successional processes, the data requirements and limitations of each of the major techniques, and the methods of applying them to ecological processes and to the management of semi-natural communities. In recent years, the application of powerful modelling procedures to ecological processes has stimulated research into ecological succession and into the possibilities of providing a sound ecological basis for the development of management strategies for natural, semi-natural and cropped ecosystems. Because of the different objectives and variation in availability of data associated with different studies, and because of the characteristics of the techniques, no single approach is recommended. Furthermore, ecological research involves a recognition that it is the change in ecosystem parameters that needs to be measured rather than the state at which an ecosystem finds itself at any particular time. In the past, ecological research has tended to concentrate on the static rather than dynamic models. This Handbook, therefore, ventures into relatively new ground. (Lantz-PTT)
W90-03198

STUDY, USE, AND PROTECTION OF SMALL AND MEDIUM RIVERS.
V. S. Altunin, V. I. Dmitruk, and V. F. Pankratov.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 9, p 542-547, March 1989. 1 fig, 12 ref.

Descriptors: *Environmental protection, *Dam effects, *Rivers, *Water resources development, *Hydrologic data collections, *Discharge measurement, Annual runoff, Hydroelectric power, Streamflow, Water management, Hydrologic models, Gaging stations, Meteorological data collection, Water potentials, USSR, Environmental impact, Fish hatcheries, Regulated flow.

Insufficient knowledge about the channel regime of rivers makes it difficult to rationally use rivers as sources of water supply, irrigation, and for construction of hydraulic structures for hydroelectric power. Rivers are classified as small and medium according to their drainage area, length, and runoff. These properties can differ for rivers in arid and semiarid regions. In the absence of observations of the runoff characteristics of a river, it is necessary to substantiate water management construction on the basis of indirect methods of calculation by hydrologic models and interpolation. An increase of the accuracy of the methods used depends on the number of hydrometric observation stations and an improvement of their spatial distribution. The volume of available information on runoff can be substantially increased by using extensive meteorological and physiographic data in addition to the available hydrometric data. These factors were taken into account when creating an improved method of calculating the characteristics of the annual runoff of rivers, namely the indicator of potential water resources of a territory. The developed methods are being used for substantiating water management projects in the European USSR. To improve the methods of estimating the hydropower potential of small and medium rivers, small hydrostations can be constructed to perform ecological impact studies. To improve the schemes of streamflow regulation and hydropower use of the runoff of medium rivers and small river tributaries the construction of small reservoirs (with the installation of small hydrostations) in the upper reaches of reservoirs is recommended, primarily on stretches without a floodplain. It is also advisable to construct fish nurseries for breeding and rearing commercial fish. (Geiger-PTT)
W90-03253

ECOLOGICAL ASPECTS OF THE OPERATION OF THE KIEV HYDROELECTRIC STATION IN A PUMPED-STORAGE REGIME.
L. A. Sirenko, A. I. Denisova, I. E. Dyachuk, L. E. Kostikov, and A. V. Kureishevich.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 9, p 547-550, March 1989. 2 fig, 1 tab, 7 ref.

Descriptors: *Dam effects, *Ecological effects, *Hydroelectric plants, *Reservoir operation, *Pumped storage, Biochemical oxygen demand, Dissolved oxygen, Water quality, Oxygen deficit, Iron, Reservoir fisheries, Nitrogen compounds, Turbidity, Aquatic bacteria, Cyanophyta.

Four units of the Kiev hydroelectric pumped-storage station were tested at a rate of from 70-240 cu m/sec of water from the lower pool of the reservoir to the upper pool for more than 70 hr to ascertain the hydrological, hydrochemical, hydrobiological, and fisheries effects on the dam stretch of the Kiev reservoir. Results showed that during the pump regime of operation the movement of the water masses changed direction in the upper pool of the reservoir. Restructuring of the currents with descent of the maximum speeds toward the bottom caused roiling of part of the bottom sediment and removal of organic and finely divided mineral particles into the surface water layers. Operation of the units in a pump regime promoted equalization of the oxygen content and pH over the entire depth eliminating the oxygen deficit near the bottom and optimizing the processes of self-purification. No effects on nitrates, nitrites, ammonium nitrogen and dissolved iron or its general mineralization were observed. Under the effect of the pump regime of operation of the units a 16-20% increase of the content of organic nitrogen in the water was noted. No negative effect on the bacterioplankton was noted. The BOD did not exceed the standard values for clean and slightly polluted open water bodies. A decrease in the proportion of blue-green algae was noted. About 300 fishes of various size and age were traumatized due to pumping. (Geiger-PTT)
W90-03254

ENVIRONMENTAL INFLUENCES ON THE OYSTER INDUSTRY ALONG THE WEST COAST OF FLORIDA.
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
R. L. Allen, and R. E. Turner.
Journal of Shellfish Research JSHRDA, Vol. 8, No. 1, p 95-104, June 1989. 7 fig, 4 tab, 29 ref.

Descriptors: *Estuarine fisheries, *Oysters, *Florida, *Population density, *Environmental effects, Air temperature, Flow discharge, Climates, Ecological effects, Fishing, Estuaries, Flooding, Model studies, Regression analysis.

The variations in oyster landings along the west coast of Florida (currently 54-57 million annually) were analyzed to determine the effects of both natural and man-induced changes in the environment on yields. Fluctuations in yields have been related to natural phenomena such as floods, droughts, and hurricanes, or to human impacts such as overfishing, regulations, and habitat alterations. Although estuarine environmental changes are known to affect oyster production, the relationships between specific critical periods of environmental change and current and future changes in yield have not been well documented. Multiple regression models (range of R squared from 0.42 to 0.91) predicting Florida's oyster yields (west coast only), most of which are for single bay systems, were responsive to spring river discharge and winter air temperature variables. The west coast of Florida has a strong spring harvest that is not severely affected by flooding conditions and that occurs before high temperatures and salinities increase the threat of disease and predation. Spring flooding and summer storms and hurricanes affect the fall and winter oyster harvest. Annual variations in the biological system were viewed as resulting, in part, from climatic factors that the fishing industry responds to the following year. Human interventions also affect the system; management has increased potential yields by deposit-

Group 6G—Ecologic Impact Of Water Development

ing substrate suitable for oyster-spat colonization and growth. These quantified changes in climate, state management, and the fisherman's effort all contribute in interrelated ways to influence variations in annual harvest. (Author's abstract)
W90-03263

FORAGING IN CENTRAL VALLEY AGRICULTURAL DRAINAGE AREAS.
California Univ., Davis. Dept. of Applied Behavioral Sciences.
M. Campbell, and L. C. Christensen.
California Agriculture CAGRA3, Vol. 43, No. 3, p 23-25, May-June 1989. 2 tab.

Descriptors: *Path of pollutants, *Water pollution effects, *Central Valley, *California, *San Joaquin Valley, *Kesterson Reservoir, *Agricultural watersheds, *Selenium, *Public health, Fishing, Hunting, Food habits, Drainage area, Foraging.

Evidence of selenium accumulation in soil and sediment prompted an identification of high-risk groups of people who collected plants and animals in the drainage area of the central San Joaquin Valley. The term 'foraging' was used to mean all use of flora and fauna for consumption, including hunting, fishing, frogging, and the collection of crayfish and edible plants. The study was conducted between January and May of 1987. Eighty-five interviews were conducted with foragers themselves or people who could provide detailed accounts of foraging activities, including canal tenders, the California departments of Fish and Game and of Parks and Recreation, Merced County Public Health officers, state police, U.S. Fish and Wildlife Service, farmers, duck club managers, and ranchers. Informants were asked who foraged, where, how, how often, when, and for what. Foragers in the study area were divided into four categories: the hunting or fishing for sport, the generalists, commercial foragers and 'true foragers'. These categories were distinguished by the foragers' choice of equipment, technique, and location, as well as by what they foraged and what they did with the items they collected. Foragers collected rabbit, squirrel, skunk, raccoon, otter, beaver, muskrat, coyote, opossum, weasel, and badger as well as fish, shellfish, crayfish, edible plants, birds, and bird eggs. The survey indicated that only a small portion of the family diet of Southeast Asians surveyed is composed of foraged items. This is most likely true for all ethnic groups foraging in the drainage area. Commercial activities, such as the sale of trash fish, waterfowl, frogs, and shellfish, were practiced by generalists, commercialists, and true foragers, and markets for foraged items extended as far as Los Angeles and Seattle. The variety of user groups far exceeded original estimates. Nevertheless, the amounts and frequency of consumption are probably not great enough to be a health hazard to any one person or group. (Ence-PTT)
W90-03323

HYDRAULIC ENGINEERING: GLOBAL CHALLENGE.
Polytechnic Univ., Brooklyn, NY.
G. Bugliarello.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 7, p 863-868, July 1989. 7 ref.

Descriptors: *Environmental protection, *Hydraulic engineering, *Environmental engineering, *Water demand, *Water management, Population dynamics, Long-term planning, Water pollution control.

At fifty years from the foundation of the Hydraulic Division of the American Society of Civil Engineers, hydraulicians and hydraulic engineers face an unprecedented new global challenge stemming from the overburdening of the environment and the accelerating demands for water caused by the rapid growth of population and industry worldwide. The principal challenges fall in the following categories: subsidence and falling water tables, droughts and floods, spills and dumping, the need for hydropower, the aging of the hydraulic infrastructure and inadequate technology transfer, and

hydraulic engineering for life in space. Obstacles faced by the profession are: 1) it is divided into many groups and divisions; 2) its research is not sufficiently supported; and 3) it is not convinced of the urgency of the problems. Two actions are suggested. The profession should organize its efforts to more effectively address the 'new first order problems,' and it should take leadership in the world community to find new ways to protect our environment. (Ence-PTT)
W90-03329

INCREASING DAMMING OF THE PARANA BASIN AND ITS EFFECTS ON THE LOWER REACHES.
Consejo Nacional de Investigaciones Cientificas y Tecnicas, Buenos Aires (Argentina).
A. A. Bonetto, J. R. Wais, and H. P. Castello.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 4, p. 333-346, November-December 1989. 6 fig, 2 tab, 54 ref.

Descriptors: *Dam effects, *Parana River, *Suspended solids, *Fisheries, *Fish migration, *Ecological effects, Flood plains, Fish barriers, Phosphorus, Eutrophication, Cyanophyta, Anabaena, Microcystis, Reservoirs, Organic matter, Flow regulation, Floods, Guayra Falls.

The development of large impoundments along the Parana River (which runs through several countries in South America), particularly on the Superior section, with fifteen large dams having a capacity over 25,000 MW, has had important hydrological and ecological impacts on the lower reaches. The retention of large amounts of suspended solids by the dams has caused a significant reduction of phosphorus concentrations. With river impoundment and water eutrophication, Cyanophiceae currently dominate during spring and summer, with brief but dense blooms of Anabaena spiroides and Microcystis aeruginosa. Many fish of the Superior Parana have been dispersed downstream since the Itaipu reservoir covered the Guayra falls, the natural barrier for these fish. The most important effects of Superior Parana dams are related to the changed hydrological regime in the alluvial Middle and Lower reaches. This floodplain plays an important role in the bioproductivity of the river. Fisheries production depends to a high degree on the relationship of the river and its alluvial valley, where the alevines and small fish of migratory species develop after spawning. During falling river levels the waters carry large quantities of organic matter, floating vegetation, important amounts of plankton and fish from the alluvial plain to the river. Before the dams, the river defined two subsystems which were joined for about six months during the flood season and effectively isolated during low water periods. Since the commencement of river impoundment and flow regulation, the river ecology has begun a sequence of changes especially within the alluvial reaches. (Author's abstract)
W90-03507

EFFECT OF STREAM REGULATION ON POPULATION PARAMETERS OF ATLANTIC SALMON (SALMO SALAR L.) IN THE RIVER LAERDALSELVA, WESTERN NORWAY.
Oslo Univ. (Norway). Lab. for Freshwater Ecology and Inland Fisheries.
R. J. Brooks, P. S. Nielsen, and S. J. Saltveit.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 4, p. 347-354, November-December 1989. 6 fig, 1 tab, 21 ref.

Descriptors: *Flow control, *Regulated flow, *Ecological effects, *Laerdalselva River, *Fisheries, *Salmon, Water temperature, Fish physiology, Stream fisheries, Smolt, Norway.

The Laerdalselva River in West Norway was regulated in the autumn of 1974. Regulation led to an increase in winter flow and a decrease in summer flow in a section where there was natural production of salmon. A slight decrease in summer temperature was also recorded in the uppermost part of this section. No data existed on juvenile Atlantic salmon before regulation and the regulation effect on juvenile fish population parameters is therefore

based on samples taken from adult salmon in the period 1969 to 1984. No differences in growth, smolt age, and smolt size which could be related to the regulation of the river were found. The smallest mean sizes of yearlings (0+) were found in 1964 and 1967. After regulation the mean size was never lower than before. Mean smolt age was between 3.1 and 3.9 years, but after regulation never exceeded that found before. River growth was slow, three year old smolts growing faster than four year old smolts. However, there were no differences in river growth before and after regulation. (Author's abstract)
W90-03508

ORGANIC MATTER TRANSPORT AND RETENTION IN A BLACKWATER STREAM RECOVERING FROM FLOW AUGMENTATION AND THERMAL DISCHARGE.
Montana Univ., Polson. Flathead Lake Biological Station.
For primary bibliographic entry see Field 5G.
W90-03510

ENDANGERED FISH SPECIES OF THE DANUBE RIVER IN AUSTRIA.
Vienna Univ. (Austria). Limnologische Lehrkanzel.
F. Schiemer, and T. Spindler.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 4, p. 397-407, November-December 1989. 8 fig, 1 tab, 13 ref.

Descriptors: *Austria, *Dam effects, *Danube River, *Fisheries, Stream banks, Bioindicators, Endangered species, Backwater, Hydroelectric plants, Regulated flow, Water quality.

The ecological affinity of fish species to different habitat types in the course of their life cycles was investigated in the free-flowing sections of the Austrian Danube. The results point to the great significance of the degree of hydrological integration between the river and its adjoining waters. In the breeding and fry stage, rheophilic species are bound to the river itself, but the preferred zones show great variations according to both fish age and species. A highly structured shoreline is important in providing a gradient of water current and a spectrum of food sources. Regulated embankments are characterized by an extremely reduced fauna with low population densities of eurytopic species. These results give evidence that the conservation of the characteristic species association is incompatible with the planned hydroelectric power dams in the remaining, free flowing zones of the Danube. The results show that the fish fauna is an excellent indicator of the ecological quality of large river systems, because of the various requirements of well-adapted species. An analysis of the fry populations and its distribution pattern is particularly appropriate for river quality assessments and can provide guidelines for conservation management. (Peters-PTT)
W90-03512

7. RESOURCES DATA

7A. Network Design

ROLE OF SATELLITE REMOTE SENSING FOR MONITORING OF SURFACE WATER RESOURCES IN AN ARID ENVIRONMENT.
Central Arid Zone Research Inst., Jodhpur (India).
K. D. Sharma, S. Singh, N. Singh, and A. K. Kalla.
Hydrological Sciences Journal HSJODN, Vol. 34, No. 5, p 531-537, Oct 1989. 2 fig, 2 tab, 11 ref.

Descriptors: *Remote sensing, *Satellite technology, *India, Surface water, Monitoring, Landsat thematic mapper, Mapping.

Water bodies up to 0.9 ha surface area, which are indistinguishable by Landsat Multispectral Scanner (MSS) due to the latter's poor spatial resolution of 80 m, can be identified and mapped reliably and reasonably within plus or minus 10% accuracy by

Landsat Thematic Mapper (TM) false color composite because of its higher spectral and spatial resolution of 30 m. The water bodies are distinctly visible in light to dark blue tone with varying size, shape and fine texture. In Jodhpur district, 135 Nadis containing water were identified and mapped. Comparative study of Landsat TM and the Survey of India topographical maps revealed reductions in the water surface up to 1.8 to 2.4 times and drainage basin areas up to 6.0 to 8.0 times over a period of 28 years (1958-1986) due to the biotic interference resulting in desertification in the large adjoining areas. (Author's abstract)
W90-02760

RISK-BASED SELECTION OF MONITORING WELLS FOR ASSESSING AGRICULTURAL CHEMICAL CONTAMINATION OF GROUND WATER.
T. D. Scheibe, and D. P. Lettenmaier.
Ground Water Monitoring Review GWMRDU, Vol. 9, No. 4, p 98-108, 1989. 3 fig, 2 tab, 15 ref. Washington Water Research Center Grant A-139-WASH.

Descriptors: *Network design, *Water quality, *Pollutant identification, *Monitoring, *Wells, *Agricultural chemicals, *Public health, Algorithms, Contamination, Hierarchical strategies, Risks, Case studies, Washington, Ethylene dibromide.

Monitoring of water supply wells has long been a responsibility of public health agencies. Current concerns about the health effects of agricultural chemicals has created a dilemma for public health agencies, because sampling costs for trace organic chemicals are much higher than for bacteriological parameters. A three-level hierarchical strategy for jointly assessing contamination risk of water supply wells by agricultural chemicals, and prioritizing wells for sampling has been developed. At the first level a determination is made as to data needs and availability, monitoring objectives are defined, and the scope of the monitoring program is established. At the second level, risk or contamination susceptibility factors are identified, and algorithms for quantifying contamination risk as a function of the susceptibility factors are developed. At the third level, the algorithms are calibrated using pilot data, and an optimization scheme for prioritizing additional wells for sampling is developed based on either minimization of the aggregate health risk and risk uncertainty, or on information gained through sampling. The monitoring of Whatcom County, Washington, domestic wells for ethylene dibromide (EDB), a highly toxic soil fumigant whose registration was suspended in 1983 by the U.S. Environmental Protection Agency, is used as a case study for testing of Levels Two and Three of the hierarchy. In the case study, the initial data consisted of EDB concentrations and ancillary data, such as well depth and pumping rate, for 24 wells already sampled. Susceptibility factors were identified, and a Level Three algorithm was used to prioritize the next 10 wells from among 54 additional candidate wells for a second stage of sampling. The sensitivity of the monitoring well selection, and risk-benefit tradeoff are evaluated for different monitoring budgets, risk susceptibility parameters, and risk-benefit tradeoff criteria. (Author's abstract)
W90-02765

SMALL-SCALE RETROSPECTIVE GROUND WATER MONITORING STUDIES FOR AGRICULTURAL CHEMICALS: STUDY DESIGN AND SITE SELECTION.
Blasland, Bouck and Lee, Syosset, NY.
J. M. DeMartinis.
Ground Water Monitoring Review GWMRDU, Vol. 9, No. 4, p 167-176, 1989. 4 fig, 7 ref.

Descriptors: *Pollutant identification, *Sampling, *Data acquisition, *Pesticides, *Monitoring, *Agricultural chemicals, *Groundwater pollution, Regulations, Field tests, Topography, Water table.

A small-scale retrospective ground water monitoring study is designed to determine if, after years of normal usage, an agricultural chemical has leached

to ground water. The U.S. Environmental Protection Agency, Office of Pesticide Programs, has established draft guidelines and suggested field protocols for such studies. Small-scale retrospective studies are ordinarily broken into a series of tasks that lead to the selection of a suitable test side(s) by determining on a national scale where to monitor; meeting minimum hydrogeologic and agronomic criteria; and establishing a ground water monitoring program. A detailed hydrogeologic vulnerability analysis is conducted in product use areas for the chemical being studied. A series of screening steps results in a subset of moderate-to high-use counties that are underlain by permeable soils and vulnerable to ground water impacts from agricultural chemicals. Once these counties are determined, suitable test fields can be selected. The hydrogeologic and agronomic criteria are not always easily met. For example, the topography and shallow water-table criteria could eliminate key agricultural areas in the United States where the agricultural chemical to be monitored may be used. However, the data generated during these field-scale retrospective studies, when properly conducted, can provide information regarding whether or not a particular agricultural chemical has leached to ground water under worst-case conditions. (Author's abstract)
W90-02772

WATER QUALITY AND SUPPLY, CORTINA RANCHERIA, COLUSA COUNTY, CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-02850

SIMULATION OF STREAMFLOW IN SMALL DRAINAGE BASINS IN THE SOUTHERN YAMPA RIVER BASIN, COLORADO.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 2A.
W90-02856

GROUNDWATER MONITORING NETWORK DESIGN.
Wright State Univ., Dayton, OH. Dept. of Geology.
H. A. Loaiciga.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 371-376, 5 ref.

Descriptors: *Monitoring, *Network design, *Groundwater pollution, *Pollutant identification, Plumes, Errors, Statistics, Data acquisition, Monitoring wells, Computers.

The design of a groundwater quality monitoring network is an important aspect of aquifer restoration and prevention of groundwater pollution. Network design means the selection of the number and locations of sampling wells at a site where contamination exists. Network design considerations, plume detection, estimation errors, geostatistical estimation, and solution of the network design problem are discussed. The design of groundwater monitoring networks is a function of (1) the statistical heterogeneity and geologic anisotropy of the aquifer; (2) the hydrodynamics of plume migration; (3) the practical decisions that result from a data acquisition program; and (4) budgetary constraints. Simultaneous treatment of these factors and their incorporation into a mathematical (combinatorial) formulation leads to a design for the best well locations. For a number or reasons the design problem is difficult to solve. These reasons include: the decision variables are binary; the problem is nonlinear in the objective function as well as the constraints; the covariance structure (determined by the hydrologic setting) of the concentration field most likely is unknown, implying that there must be a parameter estimation module embedded in the program. With the availability of high-speed supercomputers the solution of the optimization problem is approached more efficiently with a random, combinatorial search for the optimal

number and location of sampling wells. (See also W90-03036) (Rochester-PTT)
W90-03090

PROTOCOL FOR RELIABLE MONITORING OF GROUNDWATER QUALITY IN KARST TERRANES.
National Park Service, Mammoth Cave, KY.
For primary bibliographic entry see Field 7B.
W90-03147

U.S. ENVIRONMENTAL PROTECTION AGENCY'S STRATEGY FOR GROUND WATER QUALITY MONITORING AT HAZARDOUS WASTE LAND DISPOSAL FACILITIES LOCATED IN KARST TERRANES.
Environmental Protection Agency, Washington, DC. Office of Research and Development.
For primary bibliographic entry see Field 2F.
W90-03162

COST-EFFECTIVENESS OF THE STREAM-GAGING PROGRAM IN KENTUCKY.
Geological Survey, Reston, VA. Water Resources Div.
K. J. Ruhl.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4067, 1989. 57p, 5 fig, 8 tab, 18 ref.

Descriptors: *Kentucky, *Water resources data, *Network design, *Stream gaging, *Surface water, Data collections, Hydrologic data, Data acquisition.

This report documents the results of a study of the cost-effectiveness of the stream-gaging program in Kentucky. The total surface-water program includes 97 daily-discharge stations, 12 stage-only stations, and 35 crest-stage stations and is operated on a budget of $950,700. One station used for research lacks adequate source of funding and should be discontinued when the research ends. Most stations in the network are multiple-use with 65 stations operated for the purpose of defining hydrologic systems, 48 for project operation, 47 for definition of regional hydrology, and 43 for hydrologic forecasting purposes. Eighteen stations support water quality monitoring activities, one station is used for planning and design, and one station is used for research. The average standard error of estimation of streamflow records was determined only for stations in the Louisville Subdistrict. Under current operating policy, with a budget of $223,500, the average standard error of estimation is 28.5%. Altering the travel routes and measurement frequency to reduce the amount of lost stage record would allow a slight decrease in standard error to 26.9%. The results indicate that the collection of streamflow records in the Louisville Subdistrict is cost effective in its present mode of operation. In the Louisville Subdistrict, a minimum budget of $214,200 is required to operate the current network at an average standard error of 32.7%. A budget less than this does not permit proper service and maintenance of the gages and recorders. The maximum budget analyzed was $268,200, which would result in an average standard error of 16.9% indicating that if the budget was increased by 20%, the percent standard error would be reduced 40%. (USGS)
W90-03540

INDEX OF SURFACE-WATER STATIONS IN TEXAS, JANUARY 1989.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7B.
W90-03542

7B. Data Acquisition

GOES SATELLITE DATA IN RAINFALL ESTIMATION.
Florida Univ., Gainesville. Dept. of Agricultural Engineering.

Group 7B—Data Acquisition

For primary bibliographic entry see Field 2B.
W90-02573

HYDROLOGIC EFFECTS ON WATER LEVEL CHANGES ASSOCIATED WITH EPISODIC FAULT CREEP NEAR PARKFIELD, CALIFORNIA.
Geological Survey, Menlo Park, CA.
E. A. Roeloffs, S. S. Burford, F. S. Riley, and A. W. Records.
Journal of Geophysical Research (B) JJGBDU, Vol. 94, No. 9, p 12,387-12,402, September 10, 1989. 11 fig, 5 tab, 28 ref.

Descriptors: *Geohydrology, *Geologic fault movement, *Earthquake engineering, *Water level fluctuations, *Geologic fractures, Reservoirs, Monitoring wells, Creep, Shallow water, Well data, Deep water, Vertical flow, Flow measurement, Water table fluctuations, Strain measurement, Tidal effects, Prediction.

As part of the Parkfield, California, earthquake prediction experiment, water level is monitored in a well 460 meters from the main trace of the San Andreas fault, in the preparation zone of the anticipated Parkfield earthquake. The well configuration allows water level to be monitored in two fluid reservoirs at depths of 85 and 250 meters below land surface. During 1987, water level changes were recorded during 12 of the 18 episodes of accelerated fault creep detected by a creep meter spanning the fault trace 750 meters northwest of the well. The creep-related water level changes persist for as long as two months. These data suggest that the transient nature of the water level changes in the shallow interval is due to vertical flow to the water table and is not evidence that creep events propagate past the well. Phase leads of tidal constituents in the water level data from the shallow interval relative to the same constituents in the local volume strain tide support the interpretation of significant flow to the water table at periods of one day or less. The form of the water level changes in the deep interval is affected by horizontal flow to the well bore. This effect can be removed from the water level records using a theoretical response curve constrained by the phases of tidal constituents in the deep interval relative to the local volume strain tide. For the events where the signal in the shallow interval has been large enough to measure, the sizes of the simultaneous water level changes in the two reservoirs are consistent with the same amounts of volume strain occurring at both depths. (Author's abstract)
W90-02577

COMPOSITE ANALYTICAL MODEL FOR ANALYSIS OF PUMPING TESTS AFFECTED BY WELL BORE STORAGE AND FINITE THICKNESS SKIN.
National Water Research Inst., Burlington (Ontario).
K. S. Novakowski.
Water Resources Research WRERAQ, Vol. 25, No. 9, p 1937-1946, September 1989. 9 fig, 22 ref.

Descriptors: *Pumping tests, *Groundwater storage, *Wells, *Aquifer testing, *Aquifer characteristics, Storage coefficient, Transmissivity, Geologic formations, Boundary conditions, Mathematical analysis, Laplace equation, Boreholes, Drawdown, Radial wells, Hydraulic permeability.

The most commonly used method to measure the transmissivity and storativity of a geological formation between two or more wells is the pumping test. The solution of a boundary value problem for dimensionless drawdown in the pumping well, skin region, and formation is derived using the Laplace transform method. The solution is verified by comparison to solutions of pumping test problems with well bore storage only, with a composite formation only, and with well bore storage and infinitesimally thin skin. Type curves obtained by numerically inverting the solution for drawdown in the formation are used to illustrate the influence of well bore storage, the effect of skin region characteristics, and the effect of radial distance. These show that the influence of a finite thickness of skin of reduced

permeability is clearly identifiable over a fairly broad range of radial distance when well bore storage effects are minimized. The type curves are uniquely defined provided that the skin region is of nonzero thickness. Type curves obtained for the solution for drawdown in the skin region are used to illustrate the effect of outer boundary conditions. These curves show that early time data not influenced by well bore storage effects are required to detect the presence of outer boundaries of reduced permeability. Drawdown data at late time, although less influenced by well bore storage effects, are subject to nonuniqueness with regard to the characteristics of the skin and formation regions. Outer boundaries of enhanced permeability are identified only at early time and are almost entirely masked by well bore storage at later time. (Author's abstract)
W90-02583

SAMPLING PROPERTIES OF PARAMETER ESTIMATORS FOR A STORM FIELD RAINFALL MODEL.
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
W. F. Krajewski, and J. A. Smith.
Water Resources Research WRERAQ, Vol. 25, No. 9, p 2067-2075, September 1989. 7 fig, 14 ref.

Descriptors: *Statistical models, *Model studies, *Meteorology, *Sampling, *Rainfall, *Parametric hydrology, *Estimating equations, Radar, Monte Carlo method, Field tests, Rain gages, Feasibility studies, Statistical analysis.

Recent progress in statistical modeling of space-time rainfall brings to the forefront the problem of parameter estimation. A statistical model of rainfall fields has been developed. The model parameters can be estimated from radar and rain gage data. The radar data are used only to estimate the spatial features of the model. The rain gage data are used to estimate the magnitude of rainfall. The parameter estimators are based on the method of moments and are shown to be consistent and asymptotically normal. To investigate the small sample properties of the estimators a Monte Carlo simulation experiment has been conducted. The results indicate that for certain combinations of the true rainfall field parameters the estimation procedure leads to biased results. The model has an attractive feature in that a simple statistic can be precomputed which indicates the feasibility of the model to represent a given rainfall data set. In case the statistic indicates infeasibility of the model it is difficult to distinguish whether the proposed model is not appropriate or the data sample is too small. (Author's abstract)
W90-02593

DETERMINATION OF ARSENIC (III/V) IN AQUEOUS SAMPLES BY NEUTRON ACTIVATION ANALYSIS AFTER SEQUENTIAL CO-PRECIPITATION WITH DIBENZYLDITHIO-CARBAMATE.
Netherlands Energy Research Foundation ECN, Petten.
For primary bibliographic entry see Field 5A.
W90-02595

IMPROVED SEPARATIONS PROCEDURES FOR ISOLATING 2,3,7,8-TCDD AND 2,3,7,8-TCDF FROM CHEMICALLY-COMPLEX AQUEOUS AND SOLID SAMPLE MATRICES AND FOR DEFINITIVE QUANTITATION OF THESE ISOMERS AT PPQ TO PPT CONCENTRATIONS.
Wright State Univ., Dayton, OH. Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W90-02596

DETERMINATION OF POLYCHLORINATED DIBENZO-DIOXINS AND DIBENZOFURANS IN ENVIRONMENTAL SAMPLES USING HIGH RESOLUTION MASS SPECTROMETRY.
Environmental Protection Agency, Kansas City, KS. Environmental Services Div.
For primary bibliographic entry see Field 5A.

W90-02597

METHOD 8290: AN ANALYTICAL PROTOCOL FOR THE MULTIMEDIA CHARACTERIZATION OF POLYCHLORINATED DIBENZO-DIOXINS AND DIBENZOFURANS BY HIGH-RESOLUTION GAS CHROMATOGRAPHY/HIGH-RESOLUTION MASS SPECTROMETRY.
Triangle Labs., Research Triangle Park, NC.
For primary bibliographic entry see Field 5A.
W90-02598

ANALYSIS OF LARGE VOLUME WATER SAMPLES NEAR CHEMICAL DUMP SITES USING THE AQUEOUS PHASE LIQUID EXTRACTOR (APLE).
Ontario Ministry of the Environment, Rexdale.
Lab. Services Branch.
For primary bibliographic entry see Field 5A.
W90-02599

TRIALS USE OF A WEIGHING TIPPING-BUCKET RAIN GAUGE.
Meteorological Office, Aberporth (Wales).
C. M. Hewston, and S. H. Sweet.
Meteorological Magazine MTMGA5, Vol. 118, No. 1403, p 132-134, June 1989. 2 fig, 2 ref.

Descriptors: *Meteorological data collection, *Instrumentation, *Weather data collections, *Rain gages, Precipitation, Rainfall, Rain.

The need for a state-of-the-art rainfall rate recorder for use in trials of modern weapon systems is reviewed and a weighing tipping-bucket rain gauge (WTBR), which has been developed by the Operational Instrumentation Branch of the Meteorological Office, is described. Measurements made by the new instrument and by a nearby standard tilting-syphon rain recorder, obtained during evaluation trials, were compared. Both instruments showed similar results, with a steady increase in the rainfall rate to 0720, followed by a sharp decrease, then remaining fairly steady at about 2 mm/h. From 0710 to 0730, the WTBR collected 1.57 mm of rain, which was in reasonable agreement with that estimated from the tilting-syphon chart, which was 1.7 mm. It is shown that the prototype instrument offers the facility to monitor rainfall rates in real time. This is essential for trials that have to be conducted specifically in predetermined rates of rainfall. While there is an increased degree of error in the 10-second values, experience suggests that it is not excessive. (Friedmann-PTT)
W90-02639

HYDROLOGICAL REGIONALIZATION OF STREAMS IN VICTORIA, AUSTRALIA, WITH IMPLICATIONS FOR STREAM ECOLOGY.
Melbourne Univ., Parkville (Australia). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-02651

AQUATIC TOXICITY TEST FOR ENCHYTRAEIDS.
Battelle-Inst. e.V., Frankfurt am Main (Germany, F.R.). Dept. of Toxicology and Pharmacology.
For primary bibliographic entry see Field 5C.
W90-02666

PATCHINESS, COLLAPSE AND SUCCESSION OF A CYANOBACTERIAL BLOOM EVALUATED BY SYNOPTIC SAMPLING AND REMOTE SENSING.
Arizona State Univ., Tempe. Dept. of Zoology.
D. L. Galat, and J. P. Verdin.
Journal of Plankton Research JPLRD9, Vol. 11, No. 5, p 925-948, September 1989. 8 fig, 3 tab, 81 ref, EPA Contract 68-03-6242.

Descriptors: *Remote sensing, *Landsat images, *Limnology, *Cyanophyta, *Lakes, *Eutrophication, Chlorophyll a, Surveys, Saline lakes, Pyramid Lake, Nevada, Phytoplankton, Synoptic analysis.

Spatial patchiness and collapse of the cyanobacterium, Nodularia spumigena, were evaluated in saline Pyramid Lake, Nevada, by two synoptic ground surveys and Landsat remote sensing. Horizontal variation of surface water chlorophyll-a during the first survey ranged from 3.6 to 9790 mg/cu m and Nodularia biovolume was between 416,000 and 347,000,000 cu microm/ml. Differences in spatial and temporal resolution between synoptic ground surveys (approximately 10 meters, hours) and Landsat imagery (80 meters, seconds) yielded a poor correlation when data were matched by common ground location. A regression model for estimating chlorophyll from Landsat radiance was developed by pairing equivalent frequencies from cumulative relative frequency distributions of both variables. Wind driven advection precipitated bloom collapse shortly after the first synoptic sample and Nodularia mineralization produced high epilimnetic ammonium concentrations. Ammonium, silica from fluvial sources, and density differences between river and lake water masses stimulated succession to a Chaetoceros elmorei bloom within 8 days of the first synoptic survey. The 16 day fly-by interval of Landsat is too long to document such short-term bloom succession. Landsat imagery is most applicable for evaluating instantaneous, basin-scale horizontal patchiness and average lakewide chlorophyll concentrations, while frequent synoptic ground surveys yield more accurate estimates of meso-and micro-scale phytoplnakton patchiness and species succession. (Author's abstract)
W90-02673

CARBON AND CHLOROPHYLL CONTENT OF PHYTOPLANKTON FROM VARIOUS NUTRIENT REGIMES.
Vandkvalitetsinstitutet, Hoersholm (Denmark).
B. Riemann, P. Simonsen, and L. Stensgaard.
Journal of Plankton Research JPLRD9, Vol. 11, No. 5, p 1037-1045, September 1989. 5 fig, 32 ref.

Descriptors: *Limnology, *Culturing techniques, *Phytoplankton, *Chlorophyll, *Carbon, Algae, Diatoms, Growth rates, Eutrophic lakes, Coastal waters, Nutrients.

The relationship between chlorophyll and carbon in phytoplankton cultures and natural populations of phytoplankton was measured using simple standard extraction procedures without correction for degradation products. During exponential growth of four cultures of unicellular and colonial green algae and one diatom, chlorphyll varied from 1.22 to 6.08 % of the phytoplankton carbon content ($x = 3.03\%$). The chlorophyll content of the cultures was lower during nitrogen and phosphorous deficiency. Results from natural populations of phytoplankton from eutrophic lakes and from a coastal marine station gave values mostly ranging from 1.5 to 3.7% chlorophyll, corresponding to carbon/chlorophyll ratios of 27-67. If only a rough estimate of the phytoplankton carbon biomass is required, a simple, efficient extraction procedure can be used without any corrections for degradation products. (Author's abstract)
W90-02677

WATER QUALITY MANAGEMENT IN CANALS AND PIPELINES.
For primary bibliographic entry see Field 8B.
W90-02694

MEASUREMENT OF REAERATION IN STREAMS: COMPARISON OF TECHNIQUES.
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
J. R. Bicudo, and A. James.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 115, No. 5, p 992-1010, October 1989. 5 fig, 3 tab, 37 ref.

Descriptors: *Data acquisition, *Water analysis, *Oxygen requirements, *Dissolved oxygen, *Reaeration, Stream pollution, Oxygen transfer, Solids dissolution, Turbulent flow, Diffusion, Mathematical studies.

From both theoretical studies and 48 experimental observations of various hydraulic conditions it was

demonstrated that the oxygen absorption and benzoic acid dissolution appear to be ruled by the same diffusion processes and that a reasonable correlation exists between both the reaeration (K sub 2) and oxygen transfer (K sub L) coefficients and velocity of solids dissolution (V sub s). Although a limiting factor between oxygen absorption and solids dissolution processes was identified, it was possible to demonstrate that the ratio between K sub 2 and V sub s is strongly correlated with the turbulent and mixing conditions of the particular experimental system. The assumption that the K sub 2/K sub p ratio is constant and independent of turbulence intensity was herein confirmed again and estimated to be 1.365 + or -0.030. The study of the velocity times depth interaction effect upon the rate coefficients revealed that both K sub 2 and K sub p are less depth-dependent at low velocity levels than at higher velocity levels. The analysis of natural river data and energy dissipation response further confirms these findings. The floating soluble solids technique may offer a simple and reliable method for estimating the reaeration coefficient in natural waters. (Author's abstract)
W90-02722

MONITORING OF TRACE ORGANIC CONTAMINANTS IN ATMOSPHERIC PRECIPITATION.
Inland Waters Directorate, Burlington (Ontario). Water Quality Branch.
C. H. Chan, and L. H. Perkins.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 3, p 465-475, 1989. 7 fig, 3 tab, 30 ref.

Descriptors: *Air pollution, *Water pollution sources, *Pesticides, *Organic pollutants, *Sampling, *Great Lakes, *Polychlorinated biphenyls, Hydrocarbons, Chemistry of precipitation, Organic pesticides, Phenanthrene, Methylnapthalene, Fluoranthene, Pyrene, Agricultural chemicals.

A year-round sampler for trace organic contaminants in wet precipitation was devised that is electronically controlled and features a 0.25-meter-square stainless steel funnel with a 4-L amber glass bottle. The whole assembly is insulated and equipped with heating elements which permit collection of ice/snow samples. A small network of four sampling stations was established in the Great Lakes basin for the purpose of obtaining a refined estimate of atmospheric loading of trace organic pollutants to the Great Lakes. A total of 93 rain/snow samples was collected from the network during 1986. These samples were analyzed for organochlorine pesticides, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons. The most significant organochlorine pesticides found were alpha-HCH, gamma-HCH (lindane), and methoxychlor with concentrations in the range of 7-10 ng/L, 4-5 ng/L, and 2-7 ng/L, respectively. Polychlorinated biphenyls were also widely detected with mean concentrations of 7-10 ng/L. Polycyclic aromatic hydrocarbons were detected in about 50% of the samples. Some of the prevalent polycyclic aromatic hydrocarbons were phenanthrene, methylnapthalene, fluoranthene, and pyrene with mean concentrations of 50-200 ng/L. Deposition of agricultural chemicals (HCHs) was higher in Lake Superior and Huron but precipitation at Lake Erie and Lake Ontario contained more varieties of domestic pesticides. (Author's abstract)
W90-02753

ROLE OF SATELLITE REMOTE SENSING FOR MONITORING OF SURFACE WATER RESOURCES IN AN ARID ENVIRONMENT.
Central Arid Zone Research Inst., Jodhpur (India).
For primary bibliographic entry see Field 7A.
W90-02760

FIELD SCREENING METHOD FOR GASOLINE CONTAMINATION USING A POLYETHYLENE BAG SAMPLING SYSTEM.
Connecticut Univ., Storrs. Dept. of Geology and Geophysics.
G. A. Robbins, R. D. Bristol, and V. D. Roe.
Ground Water Monitoring Review GWMRDU, Vol. 9, No. 4, p 87-97, 1989. 12 fig, 14 ref.

Descriptors: *Samplers, *Instrumentation, *Pollutant identification, *Field tests, *Sampling, *Gasoline, Polyethylene bags, Contamination, Organic vapor detection, Benzene, Correlation analysis.

A headspace screening technique using a reclosable polyethylene bag and a total organic vapor detector is presented for assessing gasoline contamination of water and soil. The technique is shown to possess a well-founded theoretical basis that predicts linear correlation between headspace measurements and volatile constituent levels, providing pertinent conditions are stable or controlled. Laboratory analyses were performed with aqueous aromatic standards, contaminated ground water, and soil spiked with benzene and gasoline to develop and test the method. The technique has been found to possess detection limits in the low micrograms/L and fractions of mg/kg range for water and soil, respectively. The method was tested at two field sites. Good correlations were obtained between field screening results and laboratory analyses with respect to delineating the areal distribution of aromatics in the ground water, monitoring well purging, and determining the vertical distribution of aromatic levels in soil. Limits of contaminant detection will depend on the specific detection instrument in use, its calibration and its inherent sensitivity to the volatile constituents present in a sample. The method is not constituent-specific; hence, it is limited as to the level of detail it can provide. (Author's abstract)
W90-02764

ASSESSING ARKANSAS GROUND WATER FOR PESTICIDES: METHODOLOGY AND FINDINGS.
ENSECO, Inc., Boston, MA.
For primary bibliographic entry see Field 5A.
W90-02771

DIRECT PHENOTYPIC AND GENOTYPIC DETECTION OF A RECOMBINANT PSEUDOMONAD POPULATION RELEASED INTO LAKE WATER.
Liverpool Univ. (England). Dept. of Genetics and Microbiology.
For primary bibliographic entry see Field 5B.
W90-02786

DEVELOPMENT OF A SOLID MEDIUM FOR GROWTH AND ISOLATION OF AXENIC MICROCYSTIS STRAINS (CYANOBACTERIA).
Ibaraki Univ., Ami (Japan). Dept. of Agricultural Chemistry.
M. Shirai, K. Matumaru, A. Ohotake, Y. Takamura, and T. Aida.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 10, p 2569-2571, 1989. 2 fig, 2 tab, 14 ref.

Descriptors: *Culturing techniques, *Cyanophyta, *Microcystis, Eutrophication, Algal growth.

Solid media on a base of B-12 or CB medium with agarose or agarose of low melting temperature were developed for the cultivation of Microcystis species. The media with 0.4% gel showed the highest number of CFU (colony-forming units), and increasing the gel concentration resulted in a reduction of the number of CFU. There was no difference in the numbers of CFU between pour and spread plates made of the solid media. By using the solid media, 31 clones of Microcystis species were isolated from natural blooms in Lake Kasumigaura, and 5 axenic strains (1 of M. wesenbergii and 4 of M. aeruginosa) were established from the clones. (Author's abstract)
W90-02788

SIMPLE METHOD FOR DETERMINATION OF BIODEGRADABLE DISSOLVED ORGANIC CARBON IN WATER.
Universite Libre de Bruxelles (Belgium). Groupe de Microbiologie des Milieux Aquatiques.
P. Servais, A. Anzil, and C. Ventresque.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 10, p 2732-2734, 1989. 2

fig, 2 tab, 9 ref.

Descriptors: *Water analysis, *Organic carbon, *Biodegradation, *Drinking water, Testing procedures, Biodegradable dissolved organic carbon.

Determination of biodegradable dissolved organic carbon (BDOC) in waters is of particular importance for the water treatment industry. A simple method for determining biodegradable dissolved organic carbon which is applicable to surface and drinking water is proposed. It consists of sterilizing the water sample, inoculating it with autochthonous bacteria, and measuring the decrease in dissolved organic carbon concentration due to the carbon oxidization by bacteria. In order to validate the method, BDOC was determined on samples of low-organic-carbon mineral water (Evian) to which various concentrations of different substrates (amino acids, acetate, or albumin) had been added. In the range between 0.2 and 1.5 mg of carbon per liter, the agreement between added substrate concentration and BDOC is very good and validates the method. The method has been used for studying river waters and for drinking water treatment plant design. (Author's abstract)
W90-02792

ESTIMATION OF SENSIBLE HEAT FLUX FROM MEASUREMENTS OF SURFACE RADIATIVE TEMPERATURE AND AIR TEMPERATURE AT TWO METERS: APPLICATION TO DETERMINE ACTUAL EVAPORATION RATE.
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2D.
W90-02794

MEASUREMENTS OF HYDRAULIC CONDUCTIVITY OF SILT LOAM SOILS USING AN INFILTRATION METHOD.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Geography.
J. A. Van Den Berg.
Journal of Hydrology JHYDA7, Vol. 110, No. 1/2, p 1-22, Sep 1989. 11 fig, 3 tab, 48 ref.

Descriptors: *Hydraulic conductivity, *Groundwater movement, *Instrumentation, *Infiltration, *Soil water, Loam, Silt, Capillary pressure, Temporal variation.

The variability of hydraulic conductivity under saturated and near-saturated conditions and the variability of the infiltration capacity were examined for silt loam soils on marl and the results contrasted with a loamy sand. To investigate the effect of macropores the column method was used on twelve in-situ soil columns with or without an artificial crust and large enough to include representative patterns of macropore continuity. Only the effect of crusting of bare soil on saturated conductivity was studied on smaller samples. During ponded infiltration on close soils (in which macropores do not come to the soil surface) the capillary pressure head in the transmission zone most often became slightly positive. This could be related to differentiation in hydraulic properties with soil depth. Such a positive pressure head enables macropores to contribute to the conductivity of the transmission zone and explains the large difference in conductivity found between nearly saturated and completely saturated soils. The values acquired for the saturated hydraulic conductivity were characterized by considerable temporal variability. This variability can largely be attributed to the instability of macropores. (Author's abstract)
W90-02796

COMPARISON OF THREE TECHNIQUES FOR ADMINISTERING RADIOLABELED SUBSTRATES TO SEDIMENTS FOR TROPHIC STUDIES: UPTAKE OF LABEL BY HARPACTICOID COPEPODS.
Florida State Univ., Tallahassee. Dept. of Oceanography.
K. R. Carman, F. C. Dobbs, and J. J. Guckert.
Marine Biology MBIOAJ, Vol. 102, No. 1, p 119-125, Jul 1989. 6 fig, 28 ref.

Descriptors: *Data acquisition, *Tracers, *Zooplankton, *Copepods, *Radioactive tracers, *Intertidal areas, Trophic level, Grazing, Florida, Sediments, Microorganisms.

Microbial grazing by two species of meiofaunal harpacticoid copepods (Heteropsyllus nunni and Thompsonula hyaenae) was determined by uptake of radioactive labels following their introduction into natural sediments from a low-energy intertidal site in Florida in May 1986. Grazing was related to three methods of radioactive-label introduction: injection, pore-water replacement, and slurry. Uptake of label by harpacticoids was examined using two dual-label combinations, 3H-thymidine/14C-bicarbonate and 3H-thymidine/14C-acetate. The injection and porewater-replacement methods yielded statistically indistinguishable results. Results obtained by the slurry method differed significantly from the other two methods. It is suggested that the unique results obtained in the slurry method were a consequence of the disruption of microbial-meiofaunal spatial relationships. (Author's abstract)
W90-02823

SUPPRESSION OF ANTIBODY-PRODUCING CELLS IN RAINBOW TROUT SPLEEN SECTIONS EXPOSED TO COPPER IN VITRO.
National Fish Health Research Lab., Kearneysville, WV.
For primary bibliographic entry see Field 5C.
W90-02827

INFLUENCE OF TRIBUTYLTIN ON IN VITRO ACTIVATION OF OYSTER TOADFISH MACROPHAGES.
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 5C.
W90-02828

HUMIC MATTER ISOLATED FROM SOILS AND WATER BY THE XAD-8 RESIN AND CONVENTIONAL NAOH METHODS.
Georgia Univ., Athens. Dept. of Agronomy.
For primary bibliographic entry see Field 2K.
W90-02836

DESCRIPTION OF DATA FILES COMPILED FOR THE CENTRAL MIDWEST REGIONAL AQUIFER-SYSTEM ANALYSIS.
Geological Survey, Lawrence, KS. Water Resources Div.
J. O. Helgesen, and C. V. Hansen.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-42, 1989. 37p, 8 fig, 9 tab, 8 ref.

Descriptors: *Aquifer systems, *Aquifer characteristics, *Groundwater data, *Texas, *Hydrologic data, *Data storage and retrieval, *Regional analysis, *Geohydrologic units, *Aquifer characteristics, Data collections.

Several types of geologic and hydrologic data were collected and compiled as part of the Central Midwest Regional Aquifer-System Analysis. The study described the hydrology of Cambrian-age through Cretaceous-age rocks in all of Kansas and Nebraska and parts of eight other states. Information from both water wells and petroleum wells was obtained from numerous State, Federal, and private sources. The completeness, quality, and distribution of the data varies considerably. Most data files contain data selected to represent the regional scope of the study. The log data file contains about 850 lithologic logs and about 750 geophysical logs. The hydraulic-head data file contains about 1,400 measured water levels and about 2,600 values of equivalent freshwater head derived from drill-stem-test analyses. The hydrochemical data file contains about 2,900 water quality analyses. The aquifer-property data file contains about 1,050 values. In addition to site-specific data, areal information in the form of model-data arrays is available for initial hydraulic head, transmissivity, and vertical leakance. These data describe the major geohydrologic units studied in terms of a three-dimensional grid, 28 rows x 33 columns x 5 layers. Parts of the hydraulic-head, hydrochemical, and aquifer-property data files are proprietary. The fluid-withdrawal data file was developed for study use only. Most other data described herein are available on magnetic tape from the U.S. Geological Survey in Lawrence, Kansas. (USGS)
W90-02852

EXPERIMENT IN REPRESENTATIVE GROUNDWATER SAMPLING FOR WATER QUALITY ANALYSIS.
Geological Survey, Lawrence, KS. Water Resources Div.
T. L. Huntzinger, and L. E. Stullken.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4178, 1988. 12p, 4 fig, 3 tab, 4 ref.

Descriptors: *Sampling, *Water analysis, *Groundwater quality, *Water sampling, *Water quality, Nitrates, Irrigation wells, Observation wells.

Obtaining a sample of groundwater that accurately represents the concentration of a chemical constituent in an aquifer is an important aspect of groundwater-quality studies. Varying aquifer and constituent properties may cause chemical constituents to move within selectively separate parts of the aquifer. An experiment was conducted in an agricultural region in south-central Kansas to address questions related to representative sample collection. Concentrations of selected constituents in samples taken from observation wells completed in the upper part of the aquifer were compared to concentrations in samples taken from irrigation wells to determine if there was a significant difference. Water in all wells sampled was a calcium bicarbonate type with more than 200 mg/L hardness and about 200 mg/L alkalinity. Sodium concentrations were also quite large (about 40 mg/L). There was a significant difference in the nitrite-plus-nitrate concentrations between samples from observation and irrigation wells. The median concentration of nitrite plus nitrate in water from observation wells was 5.7 mg/L compared to 3.4 mg/L in water from irrigation wells. The differences in concentrations of calcium, magnesium, and sodium (larger in water from irrigation wells) were significant at the 78% confidence level but not at the 97% confidence level. Concentrations of the herbicide, atrazine, were less than the detection limit of 0.1 micrograms/L in all but one well. (USGS)
W90-02853

STABILITY OF NITRATE-ION IN SIMULATED DEPOSITION SAMPLES USED FOR QUALITY-ASSURANCE ACTIVITIES BY THE U.S. GEOLOGICAL SURVEY.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 5A.
W90-02858

EVALUATION OF THE EFFECTS OF WELL CONSTRUCTION MATERIALS AND GROUND-WATER SAMPLING EQUIPMENT ON CONCENTRATIONS OF VOLATILE ORGANIC COMPOUNDS.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5A.
W90-02924

EVALUATION OF A DISSOLVED OXYGEN FIELD TEST PROTOCOL.
Environmental Protection Agency, Cincinnati, OH. Municipal Environmental Research Lab.
For primary bibliographic entry see Field 5D.
W90-02950

CALIBRATION AND EVALUATION OF DISSOLVED OXYGEN SENSORS IN A PILOT SCALE ACTIVATED SLUDGE PLANT.

Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
For primary bibliographic entry see Field 5D.
W90-02951

PROPOSED STANDARD FOR MEASURE-MENT OF OXYGEN TRANSFER IN CLEAN WATER.
Michigan Technological Univ., Houghton.
For primary bibliographic entry see Field 5D.
W90-02956

COMPARISON OF DUAL NONSTEADY STATE AND STEADY STATE TESTING OF FINE BUBBLE AERATORS AT WHITTIER NARROWS PLANT, LOS ANGELES.
Manhattan Coll., Bronx, NY. Environmental Engineering and Science Program.
For primary bibliographic entry see Field 5D.
W90-02959

CROSS-BOREHOLE PACKER TESTS AS AN AID IN MODELLING GROUND-WATER RE-CHARGE.
Orange Free State Univ., Bloemfontein (South Africa). Inst. vir Grondwaterstudies.
J. F. Botha, and J. P. Verwey.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 47-52, 2 fig, 2 tab, 5 ref.

Descriptors: *Model studies, *Packer tests, *Aquifer testing, *Groundwater recharge, *South Africa, *Coastal aquifers, Saline water intrusion, Groundwater pollution, Groundwater recharge, Drill holes, Hydrologic models, Artificial recharge, Geologic fractures, Hydraulic conductivity, Principal component analysis.

Studies connected with the phreatic aquifer underlying Atlantis, South Africa, are described. This aquifer has received some polluted recharge water in the past and contamination is beginning to approach nearby production boreholes and to spread to the basement of the aquifer. Also, sea-water intrusion as a result of over-utilization of the aquifer is a possibility here. Cross-borehole packer tests as developed by Hsieh and others were employed and the numerical methods used in analyzing the results of these tests are discussed here. The Atlantis aquifer is situated in sand dunes that stretch along the west coast of South Africa from Cape Town to Saldanha. The aquifer is underlain by an impermeable layer of clay, a few meters thick, formed by the weathering of greywacke (Malmesbury formation), which underlies the sand deposits. Porous flow was observed at the contact between the sand deposits and the Malmesbury, at a depth of approximately 20 m (below mean sea level, bmsl), and fractured flow was observed at a depth of 50 m (bmsl). Calculation of the hydraulic tensor revealed that the Malmesbury formation is so fractured up to a depth of 25 m (bmsl) that it must be considered as an anisotropic porous medium. After this depth, the fracture density decreases rapidly and the flow changes completely from porous to fracture flow. At the contact of the sand the Malmesbury formation, the main principal component of the hydraulic conductivity is almost vertical, whereas the second principal component is directed perpendicular to the coast line. These results show that, not only are conditions existing along the coast at Atlantis conducive to artificial recharge, but that a porous flow model can be used with confidence when modelling artificial recharge into the Atlantis aquifer. (See also W90-02980) (Rochester-PTT)
W90-02985

COMPUTATION OF CURRENTS DUE TO WIND AND TIDE IN A LAGOON WITH DEPTH-AVERAGED NAVIER-STOKES EQUATIONS (ULYSSE CODE).
Electricite de France, Chatou. Direction des Etudes et Recherches.
For primary bibliographic entry see Field 2L.
W90-03014

TIDAL MOTION IN THE ENGLISH CHANNEL AND SOUTHERN NORTH SEA: COMPARISON OF VARIOUS OBSERVATIONAL AND MODEL RESULTS.
Liege Univ. (Belgium). Inst. de Mathematique.
For primary bibliographic entry see Field 2L.
W90-03018

SOLVING THE TRANSPORT EQUATION USING TAYLOR SERIES EXPANSION AND FINITE ELEMENT METHOD.
Systech Engineering, Inc., Lafayette, CA.
For primary bibliographic entry see Field 2H.
W90-03023

COOLING-INDUCED NATURAL CONVECTION IN A TRIANGULAR ENCLOSURE AS A MODEL FOR LITTORAL CIRCULATION.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 2H.
W90-03024

THIN ICE: RADAR IDENTIFICATION OF THIN AND NOT SO THIN LAYERS IN HY-DROLOGICAL MEDIA.
Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 2C.
W90-03033

SATELLITE OBSERVATIONS OF OCEANS AND ICE.
Cold Regions Research and Engineering Lab., Hanover, NH.
K. C. Jezek, and W. D. Hibler.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 379-382, 11 ref.

Descriptors: *Satellite technology, *Ice, *Oceans, *Remote sensing, Microwaves, Data acquisition, Mathematical models, Numerical analysis.

Data collected by satellite-borne instruments are being employed increasingly in studies of oceans and ice. Optical and infrared observations are used routinely for projects such as estimating edge and condition of the Arctic ice pack. However, at high latitudes optical instruments are limited frequently by cloud cover and the long polar night. Microwave instruments promise to provide regular and routine observations of the polar regions on a scale suitable for understanding the role of polar regions in global processes. Passive microwave imagers have been deployed successfully in space since the early 1970s. The first synthetic aperture radar (SAR) developed for geophysical observations of the earth was carried on board the SEASAT satellite, which was launched in 1978. A central problem is the sheer data volume. The polar regions alone are imaged twice daily by the Special Sensor Microwave Imager and even more data is expected from future satellites. Large-scale data bases as provided by satellite observations interact with numerical and analytic models on three levels: (1) data can be used to calibrate the model; (2) the data can be used to provide tests of model predictions; and (3) data can be used to initialize the models. (See also W90-02980) (Rochester-PTT)
W90-03034

APPLICATIONS OF REMOTE SENSING IN HYDROLOGY.
Agricultural Research Service, Beltsville, MD. Hydrology Lab.
For primary bibliographic entry see Field 2A.
W90-03035

MASS EXCHANGE BETWEEN MOBILE FRESH WATER AND IMMOBILE SALINE WATER IN THE UNSATURATED ZONE.
Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.
For primary bibliographic entry see Field 2G.
W90-03069

KARST HYDROGEOLOGY AND KARST ENVI-RONMENT PROTECTION. VOLUME 2.
For primary bibliographic entry see Field 2F.
W90-03104

METHODS FOR STUDYING SUBMARINE DISCHARGE OF KARST WATER.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2F.
W90-03120

FISSURE-KARST WATER RESOURCE EVAL-UATION IN A WELL FIELD NEAR XUZHOU.
Nanjing Univ. (China).
For primary bibliographic entry see Field 2F.
W90-03121

STUDY OF SHALLOW SEISMICS FOR PRE-DICTING COLLAPSE AND CAVE IN SOIL LAYERS.
Institute of Karst Geology, Guilin (China).
Z. Chen, Z. Qin, C. Lu, and X. Tang.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 743-750, 6 fig, 3 ref.

Descriptors: *Karst, *Subsidence, *Seismology, *Soil profiles, *Geohydrology, *Caves, *Geologic fractures, Bedrock, Karst hydrology.

In karst regions, collapses and caves in soil layers seriously affect the foundation stability of large engineering projects. Before a collapse occurs on the surface, fissures and caves with different sizes have usually been in existence in the bedrock and soil layers. Therefore, detecting the distribution of fissures and caves is very important to collapse prediction. The principles of detecting fissures and caves by the shallow seismic method are presented. The shallow refraction method and hole-to-surface seismic transmission method have been used with great success. The dynamic features of the seismic refraction wave and transmission wave are considered as the main mark for anomaly recognition. (See also W90-03104) (Author's abstract)
W90-03128

APPLICATION AND DEVELOPMENT OF ELECTROMAGNETIC WAVE TOMOGRAPHY IN KARST EXPLORATION.
Beijing Computer Center (China).
L. Liu, Z. Zhang, J. He, and Y. Wu.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 750-757, 3 fig.

Descriptors: *Karst, *Electromagnetic waves, *Tomography, Mathematical equations, Geohydrology, Algorithms, Computerized tomography.

The cross-hole electromagnetic wave transmission equation can approximate the Radon Transform. Therefore, computerized tomography based on the inverse Radon Transform can be applied to data processing of the cross-hole electromagnetic method. Three reconstruction computerized tomography algorithms (ART, SIRT and BPT) which have been improved with special reference to the geoelectrical environment of the karst areas were used to obtain solution. Several examples of field data processing show that the geological results of imaging in karst areas are good. (See also W90-03104) (Lantz-PTT)

W90-03129

USE OF REMOTE SENSING METHODS IN
GROUNDWATER PROTECTION.
For primary bibliographic entry see Field 2F.
W90-03131

PROSPECTING FOR KARST FRACTURE
GROUNDWATER IN THE WANMAN FAULT-
BLOCK MOUNTAINOUS AREA OF TAIHANG
MT. USING PHOTO-LINEAMENTS.
Ministry of Metallurgical Industry, Beijing
(China). Inst. of Geotechnics, Hydrogeology and
Photogrammetry.
G. Liu, and Z. Liu.
IN: Karst Hydrogeology and Karst Environment
Protection. Volume 2. Proceedings of the 21st
Congress of the International Association of Hy-
drogeologists, Guilin, China, October 10-15, 1988.
IAHS Publication No. 176, (1988). p 766-772, 2 fig,
3 ref.

Descriptors: *Data acquisition, *Water resources
data, *Photogrammetry, *Geohydrology, *Pho-
tography, *Karst hydrology, *Groundwater poten-
tial, *China, Water yield, Geologic fractures, Thai-
hang Mountain.

On the basis of photo-lineaments of aerial photo-
graphs, work has been conducted on siting well
points in a region situated on the Wanman fault
block, China, an area badly deficient in water
resources. These photographs indicate that: (1) due
to the difference in the associations of the rock
formations on the two sides of compressive and
compression-torsional faults, there are differences
in the water yield of the wells; (2) there are differ-
ent water yields from high-positioned and low-
positioned wells in compressional-torsional frac-
ture zones; (3) the distance between the well and
the fault line has an important bearing on the water
yield; (4) an ample water yield can be obtained
when the well is located at the position of the
intersection of faults; and (5) there is large amount
of water on the side of the vein facing a water
flow. In addition, at the pass which a compres-
sional-torsional fault line cuts across, there must be
good wells, some having a high water yield,
though the pass is located on a higher terrain. (See
also W90-03104) (Lantz-PTT)
W90-03132

LOCATION OF CONCEALED AREAS WITH
INTENSIFIED KARST-SUFFOSION PROCESS-
ES USING HELIUM-SURVEY AND HYDRO-
BIOLOGICAL DATA.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh
Problem.
V. S. Kovalevsky, and V. L. Zlobina.
IN: Karst Hydrogeology and Karst Environment
Protection. Volume 2. Proceedings of the 21st
Congress of the International Association of Hy-
drogeologists, Guilin, China, October 10-15, 1988.
IAHS Publication No. 176, (1988). p 779-784, 1 fig,
2 ref.

Descriptors: *Data acquisition, *Urban areas,
*Karst hydrology, *Groundwater budget,
*Helium, Groundwater mining, Geohydrology,
Geochemistry, Aquifers, Carbonate rocks, Karst.

Karst water is subjected to a great number of
various factors, particularly in urban areas. One of
these factors is groundwater withdrawal, that con-
tributes to the generation of hydrodynamic, geohy-
drochemical, hydrobiological, and thermal anoma-
lies in aquifers under development, as well as to
intensification of karst-suffusion processes. A com-
bination of different investigations (drilling, geo-
physical, hydrochemical, and others) were carried
out in these areas. These methods are labor-inten-
sive, expensive, inefficient, and/or inapplicable
under urban conditions. The efficiency of helium
surveys to delineate karstified zones in carbonate
rocks in an urban area is shown. The lowering of
piezometric heads in the Carboniferous aquifers
investigated results in a substantial areal distribu-
tion not only of hydrodynamic anomalies, but also
hydrochemical, thermal, and hydrobiological ones.
The helium survey made it possible to locate and

map these anomalies in space and time fairly accu-
rately. (See also W90-03104) (Lantz-PTT)
W90-03133

ISOTOPIC COMPOSITION OF HYDROGEN
AND OXYGEN OF KARST WATER AND HY-
DRODYNAMIC CONDITION IN CENTRAL
HEBEI DEPRESSION.
Institute of Geology, Beijing (China).
For primary bibliographic entry see Field 2F.
W90-03137

ENVIRONMENTAL ISOTOPIC STUDIES OF
KARST WATER SYSTEM OF THE GUOZ-
HUANG SPRINGS, SHANXI, CHINA.
China Univ. of Geosciences, Wuhan, Hubei,
China.
For primary bibliographic entry see Field 2F.
W90-03138

IMPORTANCE OF THE SAMPLING RHYTHM
IN THE HYDROCHEMICAL STUDY AND HY-
DROCINEMATICAL KNOWLEDGE OF KAR-
STIC AQUIFERS.
Centre Univ. d'Avignon (France). Hydrogeology
Lab.
For primary bibliographic entry see Field 2F.
W90-03144

PROTOCOL FOR RELIABLE MONITORING
OF GROUNDWATER QUALITY IN KARST
TERRANES.
National Park Service, Mammoth Cave, KY.
J. F. Quinlan.
IN: Karst Hydrogeology and Karst Environment
Protection. Volume 2. Proceedings of the 21st
Congress of the International Association of Hy-
drogeologists, Guilin, China, October 10-15, 1988.
IAHS Publication No. 176, (1988). p 888-893, 1 fig,
7 ref.

Descriptors: *Sampling, *Network design, *Karst
hydrology, *Groundwater quality, *Monitoring,
*Karst, Groundwater pollution, Streams, Water
sampling, Geohydrology, Sampling, Groundwater
movement, Tracers.

Problems with groundwater monitoring in most
karst terranes can be grouped into the following
four categories: (1) Where to monitor for pollut-
ants: at springs, cave streams, and wells shown by
dye-tracing to drain from the facility to be moni-
tored--rather than at non-traced wells selected be-
cause of convenient location down-gradient from
it. Wells on cave streams and fracture traces, and
randomly-located wells, can be successfully used
for monitoring, but only if tracer results show a
positive connection from the facility to them.
Often this can only be done several kilometers
away from the facility; (2) Where to monitor for
background: At springs, cave streams, and wells in
fractured rock in which the waters are geochemi-
cally similar to those to be monitored for pollut-
ants, but shown by tracing not to drain from the
facility--rather than at wells selected because of
convenient location up-gradient from it. This, too,
may have to be done several kilometers away from
the facility; (3) When to monitor: Before, during,
and after storms or meltwater events--rather than
with monthly, quarterly, semi-annual, or annual
samples; (4) How to reliably and economically
determine the answers to problems 1, 2, and 3.
Reliable monitoring of groundwater in karst ter-
ranes can be done, but it isn't cheap or easy. These
problems exist because many of the assumptions
made for monitoring flow in granular media are
not valid in karst terranes. (See also W90-03104)
(Author's abstract)
W90-03147

OUTLINE OF THE UNDERGROUND WATER
TRACING IN KARST REGIONS OF CHINA.
Guizhou Inst. of Tech., Guiyang (China). Dept. of
Geology.
For primary bibliographic entry see Field 2F.
W90-03148

STUDYING THE RECHARGE BOUNDARY OF
A KARST SPRING SYSTEM BY MEANS OF
TRACERS.
Institute of Karst Geology, Guilin (China).
For primary bibliographic entry see Field 2F.
W90-03149

GROUNDWATER TRACING AND WATER
QUALITY ANALYSIS IN THE VICINITY OF A
LANDFILL IN COUNTY MONAGHAN, IRE-
LAND.
Monaghan County Council (Ireland).
For primary bibliographic entry see Field 2F.
W90-03150

PARTICULAR DIFFICULTIES IN DETERMIN-
ING HYDRAULIC AND SOLUTE-TRANSPORT
PARAMETERS IN CARBONATE ROCKS.
Purdue Univ., Lafayette, IN. Dept. of Earth and
Atmospheric Sciences.
For primary bibliographic entry see Field 2F.
W90-03151

B, F AND SR AS TRACERS IN CARBONATE
AQUIFERS AND IN KARSTIC GEOTHERMAL
SYSTEMS IN ISRAEL.
Geological Survey of Israel, Jerusalem.
For primary bibliographic entry see Field 2F.
W90-03152

ENVIRONMENTAL AND ARTIFICIAL
TRACER STUDIES IN AN ALPINE KARST
MASSIF (AUSTRIA).
Institute for Geothermics and Hydrogeology,
Graz, Austria.
For primary bibliographic entry see Field 2F.
W90-03153

MICROCRUSTACEANS AS BIOINDICATORS
IN KARSTIC AQUIFERS: A CASE STUDY IN
THE JURA (NEUCHATEL, SWITZERLAND).
Neuchatel Univ. (Switzerland). Center of Hydrolo-
gy.
For primary bibliographic entry see Field 2F.
W90-03154

TEMPERATURE LOGS INTERPRETATION
FOR THE IDENTIFICATION OF PREFEREN-
TIAL FLOW PATHWAYS IN THE COASTAL
CARBONATIC AND KARSTIC AQUIFER OF
THE SALENTO PENINSULA (SOUTHERN
ITALY).
Bari Univ. (Italy). Ist. di Geologia Applicata e
Geotecnia.
For primary bibliographic entry see Field 2F.
W90-03155

COMBINED TRACER EXPERIMENTS--AN IM-
PORTANT TOOL FOR THE DETERMINA-
TION OF THE SORPTION CAPABILITY OF A
KARST AQUIFER.
Bundesversuchs- und Forschungsanstalt Arsenal,
Vienna (Austria). Dept. of Hydrogeology.
For primary bibliographic entry see Field 2F.
W90-03156

CHARACTERISTICS AND RESOURCE AS-
SESSMENT OF THE THERMAL GROUND-
WATER FROM THE LOWER TRIASSIC
SERIES KARST IN CHONGQING XIAOQUAN
HOTEL AREA.
Nanjiang Hydrogeological and Engineering Geo-
logical Party, Sichuan, China.
For primary bibliographic entry see Field 2F.
W90-03159

HYDROGEOLOGICAL MAPPING AND THE
USE OF REMOTE SENSING TECHNIQUE IN
THE KARST AREAS OF BOHEMIAN MASSIF.
Ustredni Ustav Geologicky, Prague (Czechoslova-
kia).
For primary bibliographic entry see Field 7C.
W90-03189

PROPOSAL OF A FORM FOR THE RECORDING OF THE MAIN KARST SPRINGS.

Padua Univ. (Italy). Dept. of Geography.
For primary bibliographic entry see Field 7C.
W90-03191

DESIGN AND ANALYSIS METHODS FOR FISH SURVIVAL EXPERIMENTS BASED ON RELEASE-RECAPTURE.

North Carolina State Univ. at Raleigh. Dept. of Statistics.
K. P. Burnham, D. R. Anderson, G. C. White, C. Brownie, and K. H. Pollock.
American Fisheries Society Monograph 5. American Fisheries Society, Bethesda, Maryland. 1987. 737p.

Descriptors: *Dam effects, *Statistical methods, *Fish populations, *Survival, *Water resources development, *Ecological effects, Columbia River, Spillways, Hydroelectric plants, Dam effects.

Statistical theory is presented to form the foundation for the analysis of survival experiments that rely on recapture or resighting data collected after the release of marked individuals. Survival experiments consist of at least one treatment and one control group, animals being marked to reflect group membership, with the purpose of comparing survival across treatment levels. An introduction to some basic statistical principles is included; this introduction is followed by development of theory specific to the type of data considered. Five experimental protocols are defined and maximum likelihood estimates of parameters are derived for each model in the sequence under each experimental protocol. An intensive battery of statistical tests of hypotheses are given to allow assessment of the validity of assumptions and to aid in model selection. Material presented in several parts of the monograph is cast in terms of fish survival experiments in relation to hydroelectric dams. Although such experiments provide a convenient example, the theory and methods presented have potential application to many other taxonomic groups and experimental situations. The methodology presented provides a rigorous, comprehensive, and practical reference on the analysis of experiments involving recapture of marked animals. The emphasis is on general inference procedures: point and interval estimates and tests of hypotheses. Comprehensive computer software (RELEASE) is provided to allow a full analysis of experimental data collected under these protocols. An interactive version of RELEASE is easy to use on currently-available microcomputers. The material is written for both biologists and statisticians in an effort to integrate theory and application. A solid foundation is provided for making inference from survival experiments using marked animals. The interaction between theory and practice under careful scrutiny of good biologists and statisticians (or other critical disciplines) will provide direction for further theory development. (Lantz-PTT)
W90-03197

SURFACE AND SUBSURFACE MAPPING IN HYDROGEOLOGY.

For primary bibliographic entry see Field 7C.
W90-03199

PROTOZOAN GRAZING AND BACTERIAL PRODUCTION IN STRATIFIED LAKE VECHTEN ESTIMATED WITH FLUORESCENTLY LABELED BACTERIA AND BY THYMIDINE INCORPORATION.

Limnologisch Inst., Nieuwersluis (Netherlands). Vijverhof Lab.
For primary bibliographic entry see Field 2H.
W90-03235

SPATIAL AND TEMPORAL VARIATION OF WATER COLUMN MEASUREMENTS IN AQUACULTURE PONDS.

Hawaii Univ., Honolulu. Dept. of Oceanography.
S. L. Wei, and E. A. Laws.
Aquaculture AQCLAL, Vol. 78, No. 3-4, p 253-266, June 1989. 12 tab, 15 ref. Hawaii Aquaculture Development Program 21576 and NOAA Grant

NA85AA-D--SG087.

Descriptors: *Water quality, *Water chemistry, *Sampling, *Data acquisition, *Spatial distribution, *Temporal distribution, *Aquaculture, *Phosphorus, *Ponds, Nitrogen, Carbon, Particulate matter, Dissolved solids, Sampling, Analysis of variance.

Horizontal, vertical, and diel variations of soluble reactive phosphorus (SRP), total dissolved phosphorus (TDP), particulate carbon (PC), particulate nitrogen (PN), and particulate nitrogen:carbon (N:C) ratios were examined in 0.4-ha, 1-m deep freshwater aquaculture ponds. Levels of sampling included horizontal locations, buckets from the same location, samples from buckets, and subsamples of samples. The variability associated with each level of sampling was estimated by a nested analysis of variance. The greatest sources of variability for all measurements were the highest (locations) and lowest (samples for particulate measurements and subsamples for dissolved measurements) levels of sampling. Locations within ponds were responsible for 75% of the variance of PC and PN, less than 35% of the variance of SRP and TDP, and less than 7% of the variance of N:C. A statistical analysis indicated that sampling at three locations, with only one sample at all lower levels of sampling, would be adequate to reduce the standard error to 10% of the mean at least 50% of the time for all dissolved and particulate measurements examined in this study. Horizontal variability was reduced when the ponds were well mixed vertically (i.e., isothermal). Consequently, determination of the temperature difference between surface and bottom water of the pond prior to sampling is recommended as an index of mixing conditions. During well mixed conditions, depth never contributed more than about 12% to the total variance for any measurement. Although time of day contributed more than 50% to the total variance for a few measurements during well mixed conditions, the magnitude of the temporal variation was small, except for particulate carbon in surface water which increased by approximately 15% from morning to afternoon. (Author's abstract)
W90-03239

GROUND-WATER CONTAMINATION PROGRAMS OF THE U.S. GEOLOGICAL SURVEY IN FLORIDA.

Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 5G.
W90-03246

NEW INSTRUMENTS FOR ROUTINE MONITORING OF STRUCTURES AT THE SAYANO-SHUSHENSKOE HYDROELECTRIC STATION.

G. G. Sakharov, V. V. Kravchenko, S. S. Kukavskii, O. M. Gonchar, and G. G. Voronov.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 9, p 523-527, March 1989. 3 fig, 1 tab, 4 ref.

Descriptors: *Instrumentation, *Dam stability, *Monitoring, *Dam foundations, *Hydraulic structures, *Measuring instruments, *Hydroelectric plants, Electrical equipment, Seepage, Temperature, Thermal analysis, Dam construction, Hydraulic machinery.

The POTsP-2 periodometer-ohmmeter is the first and only specialized instrument providing the possibility of routine monitoring of hydraulic structures with respect to the main types of primary embedded transducers being used. It combines the functions of a periodometer for monitoring and measuring vibrating-wire instruments, and at the same time its metrological characteristics correspond to the tspS-5 instrument, and of an ohmmeter. The instrument monitors seepage processes in the foundation of the structure by an analysis of the correlations of temperatures at various points of the foundations, as a consequence of which high requirements are imposed on the allowable absolute error and resolution of the temperature meter. To provide accurate temperature measurements, the TK-2 self-contained digital electrical thermometer with an extension thermal probe was developed. This instrument features a transducer of a

temperature-sensitive crystal resonator converting the temperature to the frequency of an electric signal. Microcircuits of the 176 and 561 series with micropower consumption provide the main element base of the developed instruments. Small sealed NKG-1.5 batteries are used as the supply sources of the instruments. The new instruments show a high accuracy, reliability, and satisfactory operating characteristics after long-term operation during the construction of the Sayano-Shushenskoe hydrostation. (Geiger-PTT)
W90-03249

INVESTIGATIONS ON THE EQUIVALENCE OF ANALYTICAL PROCEDURES: DETERMINATION OF CHLORIDE BY FLOW INJECTION ANALYSIS AND DIN-METHOD IN WATER ANALYSIS (UNTERSUCHUNGEN ZUR GLEICHWERTIGKEIT VON ANALYSENVERFAHREN: FLIESSINJEKTIONSANALYSE UND DIN-VERFAHREN BEI DER CHLORID-BESTIMMUNG IN DER WASSERANALYTIK).

Institut fuer Anorganische und Analytische Chemie, Technische Universitaet Berlin, Strasse des 17, juni 135, D-1000 Berlin 12.
G. Schulze, O. Elsholz, R. Hielscher, A. Rauth, and S. Recknagel.
Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 334, No. 1, p 9-12, May 1989. 7 fig, 3 tab, 11 ref. English summary.

Descriptors: *Water analysis, *Chemical analysis, *Chlorides, *Wastewater analysis, Atomic absorption spectrophotometry, Potentiometry, Water analysis, Sludge, Photometry, Comparison studies, Performance evaluation.

The German standard method for the determination of chloride in water, wastewater and sludge, laid down in the norm KIN 38405-D 1-2, is based on the titration with $AgNO_3$ and potentiometric detection for the range 7-140 milligrams/liter chloride. In order to investigate the equivalence of a more rapid method, flow injection analysis with different detection methods (photometric, potentiometric and by atomic absorption) is applied. Thirty samples of water of different types (waste, tap, surface and mineral water) are analyzed and the results are examined by a statistical test, which, according to the norm DIN 38402, part 71, is based on orthogonal regression. The test shows that the results obtained with the FIA-methods are equivalent to those from the German standard method. The three flow injection systems mentioned have a 10-36-fold higher sample frequency and a lower (down to 1/1000) sample and reagent consumption. Therefore, these FIA-methods are superior to the actual German standard method. (Author's abstract)
W90-03268

RAPID METHOD FOR THE SPECTROPHOTOMETRIC DETERMINATION OF SULFATE IN SURFACE WATER USING ION-EXCHANGE SEPARATION AND THE SULFATE AND CHLOROPHOSPHONAZO III (CPA III)-BA2+ COMPLEX REACTION.

Environmental Science Research Inst. of Guangzhou Prefecture (China).
X. C. Qiu, Y. Q. Zhu, and G. P. Liu.
Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 334, No. 1, p 25-26, May 1989. 1 fig, 2 tab, 10 ref.

Descriptors: *Ion exchange, *Water analysis, *Sulfates, *Separation techniques, *Spectrophotometry, *Surface water, Pollutant identification, Water analysis, Soil analysis, Chemical reactions.

A rapid spectrophotometric method for the determination of sulfate ion, $SO_4(--)$ in surface water is reported. It is based on the reaction of CPA (chlorophosphonazo) III-Ba(++) complex with $SO_4(--)$ in acidic medium in the presence of ethanol. Beer's law is obeyed up to 120 micrograms of $SO_4(--)$ in a 25 milliliter solution. The molar absorptivity is 6,300 liters/mole/cm at 500 nm, and the coefficient of variation varies from 1.85% to 3.10%. The absorbance remains stable for at least 24 hr and interfering ions are separated by strongly acidic

cation-exchange resin. Among the methods for determining microamounts of sulfate in water, the following can be mentioned: an indirect method using a suspension of barium chloranilate or barium chromate and the classical turbidimetric (BaSO4) method. The turbidimetric method is more convenient, but of rather low precision and sensitivity. The former methods are tedious and time-consuming, because they require the separation of the precipitation of BaSO4. In 1985, the CPA III was used for the indirect spectrophotometric determination of sulfate in soils, but the procedure was slow. (Author's abstract)
W90-03269

OPERATIONAL ESTIMATES OF REFERENCE EVAPOTRANSPIRATION.
Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering.
For primary bibliographic entry see Field 2D.
W90-03278

FRACTION OF THERMAL UNITS AS THE BASE FOR AN EVAPOTRANSPIRATION CROP COEFFICIENT CURVE FOR CORN.
Saint Rose School, Belmar, NJ.
For primary bibliographic entry see Field 2D.
W90-03281

IDENTIFICATION OF SUBSURFACE DRAIN LOCATIONS WITH GROUND-PENETRATING RADAR.
Agriculture Canada, Fredericton (New Brunswick). Research Station.
T. L. Chow, and H. W. Rees.
Canadian Journal of Soil Science CJSSAR, Vol. 69, No. 2, p 223-234, May 1989. 5 fig, 2 tab, 17 ref.

Descriptors: *Subsurface mapping, *Ground penetrating radar, *Remote sensing, *Radar, *Electrical properties, *Subsurface drains, *Tile drains, New Brunswick, Nova Scotia, Canada, Geophysical methods.

Ground-penetrating radar is a geophysical tool designated for subsurface probing of materials with contrasting dielectric properties. The applicability of this technique to locate agricultural drain tiles or tubes under some soil types and moisture conditions found in New Brunswick and Nova Scotia was evaluated. A method using ground-penetrating radar graphical outputs from adjacent, paired parallel traverses was developed to verify tile drain signatures. Over 50 drains, installed from 1 to 50 years ago, in soils developed in morainal till, glaciofluvial, and glaciomarine deposits were detected with the ground-penetrating radar system and confirmed by excavation. These included both clay and plastic drains. With experience, reliability was found to be close to 100%. The possibility of using the system for determining depth to the drain is also discussed briefly. (Author's abstract)
W90-03287

MOISTURE-RETENTION PARAMETERS FOR COARSE-TEXTURED SOILS IN SOUTHERN ALBERTA.
Department of Agriculture, Lethbridge (Alberta). Land Evaluation and Reclamation Branch.
For primary bibliographic entry see Field 2G.
W90-03288

ACID-PERSULFATE DIGESTION PROCEDURE FOR DETERMINATION OF PHOSPHORUS IN SEDIMENTS.
Southern Forest Experiment Station, Oxford, MS. Forest Hydrology Lab.
N. S. Nelson.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 18, No. 4, p 359-369, Apr 1987. 3 fig, 2 tab, 9 ref.

Descriptors: *Chemical analysis, *Phosphorus, *Sediment chemistry, *Sediment analysis, *Laboratory methods, *Soil chemistry, Digestion, Perchloric acid digestion, Chemical reactions, Storm runoff, Sedimentation, Error analysis.

At the Forest Hydrology Laboratory, total P in stormflow sediments has been determined using a perchloric acid digestion, but a less hazardous procedure for the determination was desired. A safe, convenient digestion method that generally gives good P recovery from aqueous samples uses acidified potassium persulfate. A potassium persulfate-sulfuric acid autoclave digestion was used to determine phosphorus in 10-50 mg soil and sediment samples. This safe, convenient digestion method released a large fraction of the P released by the hazardous perchloric acid digestion method. Total P in stormflow sediments by perchloric acid digestion can be predicted with acceptable accuracy from P by the acid-persulfate digestion provided that homogeneous, replicate subsamples are analyzed. Nonrepresentative subsampling is the main source of analytical error in the P results by either digestion method. (Author's abstract)
W90-03291

ESTIMATION OF SURFACE WATER EVAPORATION RATES BY CONTINUOUS RADIO-GAUGING.
Macdonald Coll., Ste. Anne de Bellevue (Quebec). Dept. of Renewable Resources.
For primary bibliographic entry see Field 2D.
W90-03292

ACOUSTIC MEASUREMENT OF RIVER DISCHARGE.
RD Instruments, San Diego, CA.
R. L. Gordon.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 7, p 925-936, July 1989. 5 fig, 2 tab, 12 ref.

Descriptors: *Moving-boat method, *Discharge measurement, *Stream gages, *Instrumentation, *Acoustics, *Stream discharge, *Water currents, *Measuring instruments, Hydraulic profiles, River flow, Water depth, Velocity.

A new moving-boat method for rapidly measuring river discharge using an acoustic Doppler current profiler (ADCP) to measure current profiles and boat velocity along transects across a river is presented. Measurements from the River Elbe, near Hamburg, Germany, are used to illustrate the method and its associated uncertainties. An ADCP measures profiles of current velocity relative to the boat and the velocity of the boat relative to the bottom. The discharge calculation depends only on these data, and it is not necessary to know either compass heading or the actual location of the boat. Furthermore, the transect can be an arbitrary curve as long as it starts near one side of the river and ends near the other. Uncertainty in discharge from random errors, biases, and missed data at the sides of the river were less than 5%. Missed data near the surface and bottom are the largest source of error unless the data are corrected by assuming model profiles. With correction, the error in estimation of total discharge is dominated by flow in the shallow water at the sides of the river. For the River Elbe, the total error appears to be about 5%. The same method can be used in shallower rivers, but as the river becomes shallower, larger fractions of the total discharge estimate will be based on extrapolations. The minimum average river depth in which useful discharge measurements can be made is around 5 to 6 m. (Author's abstract)
W90-03333

DETERMINATION OF DISSOLVED OXYGEN BY PHASE-BOUNDARY-TRANSMISSION--A POSSIBILITY TO ELIMINATE INTERFERENCES CAUSED BY SUBSTANCES IN WATER.
Technische Univ. Berlin (Germany, F.R.). Inst. fuer Technischen Umweltschutz.
D. Saurbier, and U. Pilz.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 22, No. 3, p 128-131, July 17, 1989. 4 fig, 1 tab, 8 ref. English summary.

Descriptors: *Water analysis, *Oxygen, *Dissolved oxygen, *Chemical analysis, Chemical interference, Quantitative analysis.

Normally used methods for determining dissolved oxygen can be interfered with by dissolved sub-

stances in water. Therefore it sometimes is useful to know methods for measuring dissolved oxygen, that principally are not affected by dissolved substances in water. Several kinds of measurement are presented, basing all on the principle of gassing out the dissolved oxygen by an inert transport gas. The mainly interesting technical details of the methods are discussed. The physicochemical background of interference between dissolved substances and oxygen in water is also referred. (Author's abstract)
W90-03358

POSSIBLE USE OF THE CROP WATER STRESS INDEX AS AN INDICATOR OF EVAPOTRANSPIRATION DEFICITS AND YIELD REDUCTIONS IN SWEET CORN.
Oregon State Univ., Corvallis. Dept. of Horticulture.
For primary bibliographic entry see Field 3F.
W90-03367

MODELING OF UNSTEADY FLOW IN CURVED CHANNEL.
Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 8B.
W90-03396

MODELING OF RIVERBED EVOLUTION FOR BEDLOAD SEDIMENT MIXTURES.
Laboratoire d'Hydraulique de France, Grenoble.
For primary bibliographic entry see Field 8B.
W90-03397

DILUTION DISCHARGE MEASUREMENT DURING FLOOD WAVE.
Technische Hogeschool Delft (Netherlands). Dept. of Civil Engineering.
R. Noppeney, and C. Kranenburg.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 11, p 1582-1586, November 1989. 3 fig, 6 ref.

Descriptors: *Discharge measurement, *Flood flow, *Flood channels, *Channel flow, *Flood waves, *Tracers, Dilution discharge, Computer models, Simulation.

The dilution method of measuring discharge in open channels is a suitable alternative if current meter measurements are impractical. After injecting tracer material and allowing sufficient mixing downstream from the injection point, the resulting concentration and the known rate of released tracer material determine the discharge. Both tracer and flow must fulfill several requirements for the measurement to be successful. Even in the case of a well-prepared measurement program, the requirement of steady-state conditions cannot be easily controlled. This study provides a means of evaluating and improving the accuracy of a dilution discharge measurement during flood wave conditions using a computer simulation. (Sand-PTT)
W90-03401

MEASURING UNSATURATED SORPTIVITY AND HYDRAULIC CONDUCTIVITY USING MULTIPLE DISC PERMEAMETERS.
Commonwealth Scientific and Industrial Research Organization, Adelaide (Australia). Div. of Soils.
For primary bibliographic entry see Field 2G.
W90-03411

DETERMINATIONS OF UNSATURATED HYDRAULIC CONDUCTIVITY FOR CANDLER SAND.
Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W90-03414

IMPROVED FIELD PROBES FOR SOIL WATER CONTENT AND ELECTRICAL CON-

DUCTIVITY MEASUREMENT USING TIME DOMAIN REFLECTOMETRY.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
S. J. Zegelin, I. White, and D. R. Jenkins.
Water Resources Research WRERAQ, Vol. 25, No. 11, p 2367-2376, November 1989. 11 fig, 4 tab, 19 ref. NERDDC project 1138 and NSCP grant 87/12.

Descriptors: *Soil water, *Conductivity, *Time domain reflectometry, *Geophysical exploration, *Electrical studies, *Rainfall infiltration, *Simulated rainfall, Field probes, Measuring instruments.

Volumetric water content (theta) and soil electrical conductivity (sigma) may be measured in situ using time domain reflectometry (TDR). The parallel-wire or two-wire transmission line TDR probes currently in field use suffer from unwanted noise and information loss due to impedance mismatch between the probe and the coaxial connecting cable. Symmetric, multiwire probes have been designed to minimize these problems and eliminate the need for a balancing transformer between probe and TDR device. Analysis of the electric field distributions around these new probes showed that they emulate a coaxial transmission line, and their measured characteristic probe impedances approach that of coaxial probes. Signals from the new probes permit more reliable and accurate theta and sigma measurement and are superior to those of two-wire probes with balancing transformer. The enhanced signal clarity of the new probes extends to simple diameters of at least 0.2 m. Electrical conductivity determined with the new probes is identical to that found with a coaxial cell and substantially different from that measured by a two-wire probe. The results indicate that values of sigma, determined using the Giese-Tiemann thin sample approach and measured characteristic probe impedances of coaxial or multiwire probes, agree with values of sigma measured using an ac bridge for both electrolyte solutions and soil samples to within +/-10%, provided sigma exceeds 10 mS/m. An example is given of the use of multiplexed three-wire probes in following rainfall infiltration and redistribution during and after a simulated rainfall event in the field. Infiltrated quantities of water estimated from the TDR water content profiles agreed within +/-10% with the amount applied. (Author's abstract)
W90-03423

ANALYSIS OF PULSE INTERFERENCE TESTS.
Canada Centre for Inland Waters, Burlington (Ontario).
K. S. Novakowski.
Water Resources Research WRERAQ, Vol. 25, No. 11, p 2377-2387, November 1989. 10 fig, 3 tab, 18 ref.

Descriptors: *Aquifer testing, *Pumping tests, *Groundwater storage, *Test wells, *Observation wells, *Slug tests, *Pulse interference tests, *Transmissivity, *Storativity, Laplace transform, Graphical analysis, Graphical methods, Model studies, Aquifers.

Pulse interference tests, which are conducted by monitoring the response in an observation well to a slug test conducted in a source well, are an attractive alternative to the pumping test method for determining the transmissivity and storativity of low-storativity geological formations. An analytical model for analyzing the results of pulse interference tests affected by well bore storage in the observation well was developed using the Laplace transform method. By numerically inverting the Laplace space solution the practical range of the pulse interference test method and the influence of radial distance and well bore storage on the response in the exploration well are explored. Results show that the influence of observation well storage can be significant, particularly for larger well bore storage coefficients and for almost all practical radial distances. A graphical method, based on the analytical model, was developed for analyzing the results of pulse interference tests in which observation well bore storage is negligible

and for the case where the source and observation well storage coefficients are equal. A field example is also presented to illustrate and compare the use of the analytical model and graphical method for the field case where observation well storage was present and the case where it is not. (Author's abstract)
W90-03424

TRACE ENRICHMENT AND HPLC ANALYSIS OF POLYCYLIC AROMATIC HYDROCARBONS IN ENVIRONMENTAL SAMPLES, USING SOLID PHASE EXTRACTION IN CONNECTION WITH UV/VIS DIODE-ARRAY AND FLUORESCENCE DETECTION.
Gesamthochschule Paderborn (Germany, F.R.). Dept. of Applied Chemistry.
For primary bibliographic entry see Field 5A.
W90-03433

COMPARISON BETWEEN TWO MICROTOX TEST PROCEDURES.
National Swedish Environment Protection Board, Nykoeping. Brackish Water Toxicology Lab.
For primary bibliographic entry see Field 5A.
W90-03440

ISOLATION AND RECOVERY OF ORGANO-PHOSPHORUS PESTICIDES FROM WATER BY SOLID-PHASE EXTRACTION WITH DUAL WIDE-BORE CAPILLARY GAS CHROMATOGRAPHY.
Nanco Labs., Wappingers Falls, NY.
For primary bibliographic entry see Field 5A.
W90-03443

USE OF TEXTURAL (CM) PATTERN FOR IDENTIFICATION OF DEPOSITIONAL PROCESSES AND ENVIRONMENTS OF SEDIMENTS OF THE CAUVERY DELTA.
Cochin Univ. of Science and Technology (India). School of Marine Sciences.
For primary bibliographic entry see Field 2J.
W90-03452

MODELING THE FATE OF CHEMICALS IN AN AQUATIC ENVIRONMENT: THE USE OF COMPUTER SPREADSHEET AND GRAPHICS SOFTWARE.
Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.
For primary bibliographic entry see Field 5B.
W90-03461

OPTIMIZED GEL PERMEATION CHROMATOGRAPHIC CLEANUP FOR SOIL, SEDIMENT, WASTES, AND OILY EXTRACTS FOR DETERMINATION OF SEMIVOLATILE ORGANIC POLLUTANTS AND PCBS.
Battelle Columbus Div., OH.
For primary bibliographic entry see Field 5A.
W90-03476

ONE-STEP SAMPLE PREPARATION TECHNIQUE FOR BROAD SPECTRUM GAS CHROMATOGRAPHIC/MASS SPECTROMETRIC DETERMINATION OF ORGANIC PRIORITY POLLUTANTS IN WATER.
Ontario Ministry of the Environment, Rexdale. Trace Organic Section.
For primary bibliographic entry see Field 5A.
W90-03477

LIQUID CHROMATOGRAPHIC DETERMINATION OF TOTAL FORMALDEHYDE IN DRINKING WATER.
Oak Ridge National Lab., TN. Health and Safety Research Div.
For primary bibliographic entry see Field 5A.
W90-03478

CAPILLARY COLUMN GAS CHROMATOGRAPHIC DETERMINATION OF DICAMBA IN WATER, INCLUDING MASS SPECTROMETRIC CONFIRMATION.

Sandoz Crop Protection Corp., Des Plaines, IL.
For primary bibliographic entry see Field 5A.
W90-03479

DETERMINATION OF CARBOFURAN AND ITS METABOLITES IN RICE PADDY WATER BY USING SOLID PHASE EXTRACTION AND LIQUID CHROMATOGRAPHY.
FMC Corp., Princeton, NJ. Agricultural Chemical Group.
For primary bibliographic entry see Field 5A.
W90-03480

REMOTE SENSING OF WATER PARAMETERS IN MAJURA BAY.
Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Oberpfaffenhofen (Germany, F.R.).
V. Amann, R. Doerffer, H. Helbig, T. M. Kadri, and H. Van Der Piepen.
Netherlands Journal of Sea Research NJSRBA, Vol. 23, No. 4, p 473-482, August 1989. 8 fig, 2 tab, 13 ref.

Descriptors: *Remote sensing, *Indonesia, *Radiometry, Chlorophyll, Suspended solids, Distribution patterns, Tidal effects, Vertical profiles, Color, Temperature, Temporal variability, Model studies, Fluorescence.

During the Madura Bay Remote Sensing Experiment, which was conducted as part of the Snellius-II Expedition in August, 1984, space-borne, air-borne and ship-borne radiometric data were collected. They have been analyzed in terms of chlorophyll, suspended matter, yellow substance and sea-surface temperature to map the distribution patterns and temporal variability of different water masses. The blue/green color ratio and the fluorescence line height along the flight tracks derived from the Ocean Color Radiometer (OCR) over three consecutive days indicate at least three different types of water, viz. clear ocean water in the eastern part of the Bay, mixed water with moderate contents of chlorophyll and suspended matter in the middle and western parts of the Bay and finally estuarine and river water containing large amounts of inorganic and dissolved organic matter near the mouths of Solo and Brantas rivers and in the Strait itself. Distribution patterns change from one day to the next, possibly as a result of tidal effects. Vertical radiation profiles derived from aircraft flights at different altitudes and from modelling the radiative transfer through the atmosphere give an indication of how well ocean color/chlorophyll fluorescence can be monitored through a typical tropical atmosphere from satellite altitude. Model calculations and comparative measurements show that even the small fluorescence signal (corresponding to a low pigment concentration) can still be detected above the atmosphere, while color ratios, especially in the blue part of the spectrum, are heavily masked by aerosol and Raleigh scattering and have to be corrected carefully prior to any interpretation. At all wavelengths, upwelling spectra contain a considerable amount of light specularly reflected at the sea surface. (Author's abstract)
W90-03491

EFFECTS OF OZONATION, BIOLOGICAL FILTRATION AND DISTRIBUTION ON THE CONCENTRATION OF EASILY ASSIMILABLE ORGANIC CARBON (AOC) IN DRINKING WATER.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
For primary bibliographic entry see Field 5F.
W90-03496

LABORATORY TEST OF THE SOIL CHEMICAL SUBMODELS OF TWO MODELS OF CATCHMENT ACIDIFICATION.
Stirling Univ. (Scotland). Dept. of Environmental Science.
For primary bibliographic entry see Field 5B.
W90-03502

Group 7B—Data Acquisition

CHINOOK SALMON SPAWNING SURVEYS IN DEEP WATERS OF A LARGE, REGULATED RIVER.
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
For primary bibliographic entry see Field 2H.
W90-03509

COST-EFFECTIVENESS OF THE STREAM-GAGING PROGRAM IN KENTUCKY.
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 7A.
W90-03540

INDEX OF SURFACE-WATER STATIONS IN TEXAS, JANUARY 1989.
Geological Survey, Austin, TX. Water Resources Div.
J. Rawson, E. R. Carrillo, and H. D. Buckner.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-265, 1989. 17p, 1 tab, 2 pl.

Descriptors: *Surface water data, *Surface water, *Water quality, *Texas, *Water resources data, Data collections, Hydrologic data, Discharge measurement.

As of January 1, 1989, the surface-water data-collection network in Texas included 373 continuous-streamflow, 75 continuous or daily reservoir-content, 37 gage-height, 15 crest-stage partial-record, 200 data collection platform, 7 periodic discharge through range, 27 flood-hydrograph partial-record, 27 low-flow partial-record, 43 daily chemical-quality, 17 continuous-recording water quality, 87 periodic biological, 11 lake survey, 159 period organic and (or) nutrient, 2 periodic insecticide, 28 periodic pesticide, 19 automatic sampler, 137 periodic minor element, 126 periodic chemical-quality, 75 periodic physical organic, 17 continuous-recording temperature, and 29 national streamgaging accounting network stations. Plate 1 shows the location of surface-water streamflow or reservoir-content and chemical-quality or sediment stations in Texas. Plate 2 shows the location of partial-record surface-water stations. (USGS)
W90-03542

7C. Evaluation, Processing and Publication

IMPLEMENTATION OF THE THREE-DIMENSIONAL HYDRODYNAMIC MODEL FOR THE ARABIAN GULF.
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Water Resources and Environment Div.
For primary bibliographic entry see Field 2L.
W90-02545

OPTIMAL SCHEDULING OF IRRIGATION MACHINES. I: MODEL DEVELOPMENT.
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
For primary bibliographic entry see Field 3F.
W90-02575

SMALL PERTURBATIONS SOLUTION FOR STEADY BUT NONUNIFORM INFILTRATION.
Technion - Israel Inst. of Tech., Haifa. Faculty of Agricultural Engineering.
For primary bibliographic entry see Field 2G.
W90-02587

MODELING OF TWO-DIMENSIONAL OVERLAND FLOW.
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02590

SAMPLING PROPERTIES OF PARAMETER ESTIMATORS FOR A STORM FIELD RAINFALL MODEL.
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
For primary bibliographic entry see Field 7B.
W90-02593

DIURNALLY VARYING REGIONAL CLIMATE SIMULATIONS.
Commonwealth Scientific and Industrial Research Organization, Aspendale (Australia). Div. of Atmospheric Research.
B. G. Hunt, and H. B. Gordon.
International Journal of Climatology IJCLEU, Vol. 9, No. 4, p 331-356, July/August 1989. 14 fig, 42 ref.

Descriptors: *Model studies, *Climates, *Climatology, *Air circulation, *Atmospheric physics, Soil water, Diurnal distribution, Simulation, Model testing, Weather, Clouds, Hydrologic cycle.

A detailed analysis has been made of the atmospheric variability at a number of specific geographical points as simulated with a global general circulation model. The model's performance was assessed regarding diurnal and interdiurnal variability; critical features are identified that should be monitored in climatic-change experiments. Since the model contains a number of physical processes, including cloud forecasting, three independent rain-producing mechanisms, a very responsive surface-hydrology formulation, sea-ice determination, etc., complex interactions among the various climatic components can occur. One of the clearest features of the model output was the very marked longitudinal assymmetry in atmospheric forcing arising from land-sea contrast. The vital role of the soil moisture, which depends critically on its model formulation, in determining whether this forcing is due to latent or sensible heating over land, is also demonstrated. The unique diurnal variations that were simulated at individual geographical points suggest that systematic distortions must occur in most near-surface processes in non-diurnal models. The extreme sensitivity of the convective mechanisms and the consequent impact on rainfall is noted, together with its implications for experiments involving climatic change. Finally, the interdiurnal variability of the model is illustrated by a number of examples, one of which highlights the potential misrepresentation of air-sea exchanges in models employing fixed sea-surface temperatures. (Author's abstract)
W90-02635

SURFACE HUMIDITY AND PRECIPITABLE WATER VAPOR LINKAGE OVER WEST AND CENTRAL AFRICA: FURTHER CLARIFICATION AND EVALUATION OF EXISTING MODELS.
Obafemi Awolowo Univ., Ile-Ife (Nigeria). Dept. of Physics.
J. A. Adedokun.
International Journal of Climatology IJCLEU, Vol. 9, No. 4, p 425-433, July/August 1989. 2 fig, 4 tab, 19 ref.

Descriptors: *Climatology, *Meteorology, *Precipitation, *Water vapor, *Model studies, *Rainfall distribution, *Africa, *Atmospheric water, Air circulation, Weather, Hydrologic cycle, Climates.

In the light of currently available upper air data for West Africa, an intensive examination was carried out on the linkage between surface humidity and precipitable water vapor, W, over the region, with a view to validating existing empirical models as well as identifying seasonal variability in their applicability. Precipitable water vapor was calculated using available monthly mean upper air data from 13 stations in West and Central Africa (for the period 1971-1984) and compared with results from empirical models using the Kolmogorov-Smirnov test. While overall fair agreement was obtained between actual and estimated values of W, using the power law relationship of Adedokun, the model performed better during the rainy season than during the Harmattan. Ojo's ln W-(dew point temp.) linear model, however, performs better

during the Harmattan than the rainy season. The location of the Inter Tropical Discontinuity relative to the various stations and ocean-atmosphere interaction effects act as controls to the application regime of these surface humidity based models. An update of the regression base period used may be necessary for better performance. (Author's abstract)
W90-02638

THERMODYNAMIC INDICES FOR FORECASTING THUNDERSTORMS IN SOUTHERN SWEDEN.
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping.
For primary bibliographic entry see Field 2B.
W90-02640

SENSITIVITY OF FINE-MESH RAINFALL AND CLOUD FORECASTS TO THE INITIAL SPECIFICATION OF HUMIDITY.
Meteorological Office, Bracknell (England).
For primary bibliographic entry see Field 2B.
W90-02641

CONDENSATION AND CLOUD PARAMETERIZATION STUDIES WITH A MESOSCALE NUMERICAL WEATHER PREDICTION MODEL.
Bergen Univ. (Norway). Dept. of Meteorology.
H. Sundqvist, R. Berge, and J. E. Kristjansson.
Monthly Weather Review MWREAB, Vol. 117, No. 8, p 1641-1657, August 1989. 11 fig, 37 ref, append.

Descriptors: *Meteorology, *Climatology, *Model studies, *Numerical analysis, *Clouds, *Atmospheric water, *Water vapor, Air circulation, Weather forecasting, Statistical methods.

A parameterization scheme for establishing convective and stratiform condensation parameters (with cloud water as a prognostic variable) was implemented into a fine mesh numerical prediction model. The overall model system is based on the operational fine mesh model of the Norweigan Meteorological Institute. The model variables are horizontally distributed and applied to a polar stereographic map projection. At the lateral boundaries, tendencies are obtained from analyses 6 h apart, or, in connection with operational runs, from a coarse mesh model. In case the specific humidity becomes negative (due to truncation), an adjustment to zero is performed. The missing humidity is taken from the model level below, implying that the mass of vapor in the column is conserved. The sea surface temperature is set to the climatic value of the relevant month. Parameters were established for convective condensation, stratiform condensation, and advection for cloud water. The formulation of the surface fluxes is based on the Monin-Obukhov similarity theory. A bulk consideration of the Richardson number is applied to the two layers above the surface layer when the overall stratification in the lowest atmosphere is near neutral with regard to the surface temperature. Enhanced vertical diffusion is considered where condensation occurs. The results from a 36-h integration of the model, with grid distance 50 km, indicate that the new condensation scheme contributes to an improved forecast compared to that obtained by the original model. Furthermore, from a qualitative comparison with satellite pictures, it is found that the prediction of condensation-cloud parameters is quite realistic. (Friedmann-PTT)
W90-02642

NUMERICAL STUDY OF THE EAST COAST SNOWSTORM OF 10-12 FEBRUARY 1983.
Naval Research Lab., Washington, DC.
S. Chang, K. Brehme, R. Madala, and K. Sashegyi.
Monthly Weather Review MWREAB, Vol. 117, No. 8, p 1768-1778, August 1989. 10 fig, 1 tab, 36 ref.

Descriptors: *Model studies, *Numerical analysis, *Storms, *Snow, *Meteorology, *Precipitation,

Weather, Atmospheric water, Air circulation, Atmospheric physics, United States.

A numerical study of the U.S. East Coat snowstorm of 10-12 February 1983 has been conducted with the NRL mesoscale model. The three-dimensional, hydrostatic, primitive equation model has 91 by 51 horizontal grid points with a half degree resolution in a verification domain of 100 degrees W to 60 degrees W and 25 degrees N to 45 degrees N. There are ten layers in the vertical of equal thickness. The model uses a split-explicit method for temporal integration and a second-order accurate spatial finite differencing. Model physics include precipitation on the resolvable scale and parameterized boundary layer and cumulus convection. Results from forecast experiments show that the boundary treatment has a great impact on the model performance. The constant boundary condition produces an unusable forecast after 12 h as judged by the S1 scores, while the relaxation boundary condition produces an excellent forecast. The enhancement of the initial conditions has a negligible effect on predictions when reasonable boundary updates are used for the snowstorm case. The enhanced dataset produces a slightly better, but still useless forecast when constant boundary conditions are used. Numerical experiments were also conducted to test the sensitivity of the cyclogenesis to physical processes by suppressing one or more physical processes in the model. Evaporation from the ocean modulates the location and amount of precipitation. Without the evaporation, the intensity of the cyclone remains the same but the center stays on the coast instead of staying off shore. The track of the snowstorm is such that the sensible heating from the ocean dampens the development of the cyclone by reducing the low-level baroclinicity. The latent heating important for this case; when it is suppressed, the cyclone translates at a much reduced rate and its central pressure is 10 mb higher after two days of simulation. These results are case-dependent. (Author's abstract)
W90-02643

APPLICATIONS OF INTERVENTION ANALYSIS TO MODEL THE IMPACT OF DROUGHT AND BUSHFIRES ON WATER QUALITY.
Rural Water Commission of Victoria, Armadale (Australia). Water Quality Assessment Section.
D. R. Welsh, and D. B. Stewart.
Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 40, No. 3, p 241-257, 1989. 7 fig, 7 tab, 24 ref.

Descriptors: *Model studies, *Time series analysis, *Statistical models, *Drought effects, Conductivity, Water quality, Streams, Turbidity, Bushfires, Stream discharge.

Intervention analysis is a rigorous modelling technique used to measure the effect of a shift in the mean level of a time series, caused by an intervention. A general formulation of an intervention model was applied to water-quality data for two streams in northeastern Victoria, measuring the effect of drought on the electrical conductivity of one stream, and the effect of bushfires on the flow and turbidity of the other. The nature of the intervention was revealed by using exploratory data-analysis techniques, such as smoothing and box-plots, on the time-series data. Intervention analysis was then used to confirm the identified changes and estimate their magnitude. The increased level of electrical conductivity due to drought was determined by three estimation techniques and the results compared. The best of these techniques was then used to model changes in stream flow and turbidity following bushfires in the catchment. (Author's abstract)
W90-02649

RULE-BASED ECOLOGICAL MODEL FOR THE MANAGEMENT OF AN ESTUARINE LAKE.
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Computational and Applied Mathematics.
For primary bibliographic entry see Field 2L.
W90-02656

VERIFICATION OF THE MATHEMATICAL MODEL OF NITROGEN CIRCULATION WITH AND WITHOUT LIGHT ACCESS.
Slovenska Akademia Vied, Bratislava (Czechoslovakia). Ustav Experimentalenj Biologie a Ekologie.
T. Kmet, and D. Toth.
Ecological Modelling ECMODT, Vol. 46, No. 3/4, p 135-146, August 1989. 6 fig, 5 tab, 7 ref.

Descriptors: *Mathematical models, *Nitrogen cycle, *Cycling nutrients, *Nitrogen compounds, *Light intensity, Anaerobic conditions, Model studies.

A mathematical model describing the circulation of nitrogenous compounds in an aquatic environment under anaerobic conditions was studied and described in the treatises of Leonov, and Leonov and Toth. On the basis of experimental data determined under conditions with and without light access, the coefficients K sub 1 through K sub 4 were estimated, which express the maximum substrate uptake by living organisms. It is shown that the mathematical model for the estimated coefficients K sub 1 through K sub 4 reflects both the qualitative and the quantitative disparities in the behavior of the experimental system under conditions with and without light access. (Author's abstract)
W90-02657

PROBABILISTIC VALIDATION OF COMPUTER SIMULATIONS USING THE BOOTSTRAP.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 5C.
W90-02660

APPLICATION OF SHANNON-WIENER INDEX AS A MEASURE OF POLLUTION OF RIVER GANGA AT PATNA, BIHAR, INDIA.
Rajendra Agricultural Univ., Samastipur (India). Coll. of Fisheries.
For primary bibliographic entry see Field 5A.
W90-02705

DYNAMIC MODEL OF NITRIFICATION IN FLUIDIZED BED.
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5D.
W90-02717

VARIABILITY IN PHOTOSYNTHESIS: IMPACT ON DO MODELS.
Michigan Technological Univ., Houghton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W90-02719

WATER-QUALITY MANAGEMENT THROUGH COMBINED SIMULATION-OPTIMIZATION APPROACH.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W90-02723

ESTIMATING ESTUARINE REAERATION RATES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydrology Lab.
For primary bibliographic entry see Field 2L.
W90-02726

MODELING WIND-INDUCED WATER SETUP IN LAKE ST. CLAIR.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 2H.
W90-02752

ESTIMATION OF THE PARAMETERS OF AN ISOLATED EVENT CONCEPTUAL MODEL

FROM PHYSICAL CATCHMENT CHARACTERISTICS.
Rhodes Univ., Grahamstown (South Africa). Dept. of Geography.
For primary bibliographic entry see Field 2A.
W90-02761

PHYSICALLY BASED DISTRIBUTION FUNCTION FOR LOW FLOW.
Oslo Univ. (Norway). Inst. of Geophysics.
For primary bibliographic entry see Field 2E.
W90-02762

AVAILABILITY AND CONTENT OF DOMESTIC WELL RECORDS IN THE UNITED STATES.
Research Triangle Inst., Research Triangle Park, NC. Center for Environmental Measurement.
M. C. Ganley.
Ground Water Monitoring Review GWMRDU, Vol. 9, No. 4, p 149-158, 1989. 2 fig, 2 tab, 7 ref.

Descriptors: *Data collections, *Hydrologic data, *Water resources data, *Well data, *Groundwater quality, *Data acquisition, Interagency cooperation, Legal aspects, Regulations, Domestic wells, Records.

Ground water professionals within public and private sectors use well records as data sources. Well record availability is dependent on legal requirements, filing systems, databases, and storage places. Forty-six states have statewide regulations or other legal requirements for filing completion reports for domestic wells. Fifty-one agencies across the country maintain domestic well records. Filing systems involve location, chronology, date, or number information. Thirty-one of the 51 agencies maintain varying types of databases containing record information or data related to the records. Overall, records are kept in central offices in 43 states and in regional offices in three states. The technical content of the records was evaluated for general, location, hydrogeology, and well construction information to assess the relative value of the records for use in national pesticide surveys. Technical information tabulated from the well records collected for this paper included nine items in a general category, 28 items in a well-construction category, eight items in a hydrogeology category, and six items in a location category. Items in the general and location categories identified the well location and ownership. Construction category items include those describing well-construction parameters such as grout, casing, and screen. Hydrogeology category items include static water level, aquifer media, and estimated yield. The three items always requested were owner's name, driller's name, and static water level. The three least-requested items, ranging from 16 percent to 10 percent, were packers, drilling fluid, and geologic formation. (Author's abstract)
W90-02770

PHYSICAL MODEL TO COMPLEMENT RAINFALL NORMALS OVER COMPLEX TERRAIN.
Tel-Aviv Univ. (Israel). Raymond and Beverly Sackler Faculty of Exact Sciences.
For primary bibliographic entry see Field 2B.
W90-02798

FLOOD FORECASTING BY THE FILTER SEPARATION AR METHOD AND COMPARISON WITH MODELING EFFICIENCIES BY SOME RAINFALL-RUNOFF MODELS.
Utsunomiya Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02801

DERIVING THE UNIT HYDROGRAPH BY ROOT SELECTION.
College of Technology, Dublin (Ireland).
For primary bibliographic entry see Field 2E.
W90-02802

GROUND-WATER LEVEL DATA FOR NORTH CAROLINA--1987.
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-02846

PRECIPITATION, STREAMFLOW, AND BASE-FLOW IN WEST-CENTRAL TEXAS, DECEMBER 1974 THROUGH MARCH 1977.
Geological Survey, Austin, TX. Water Resources Div.
E. L. Kuniansky.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4218, 1989. 2 (map) sheets, 8 fig, 3 tab, 14 ref.

Descriptors: *Maps, *Base flow, *Data collections, *Groundwater movement, *Hydrologic data, *Texas, *Aquifer systems, *Aquifer characteristics, Surface-groundwater relations, Precipitation, Streamflow.

Precipitation, streamflow, and base-flow data were analyzed for December 1974 through March 1977 as a part of the Edwards-Trinity Regional Aquifer-System Analysis in west-central Texas. The period of record analyzed corresponds to the calibrating period of a digital groundwater-flow model of the aquifer system currently (1988) being developed. Precipitation at individual stations ranged from 6 to 45 in/yr. Precipitation normally (1951-80) ranged from 10 to 32 in/year from east to west in the study area. Precipitation was near normal over most of the area and above normal in the southeastern part of the study area. Streamflow ranged from less than 1 in/year in the western part of the study area to 13 in/yr in the southeastern part. Streamflow was 8 in/yr above normal in the southeast. Base flow ranged from less than 0.1 in/yr in the western part of the study area to 6 in/yr in the southeastern part. (USGS)
W90-02851

STATISTICAL SUMMARY OF STREAMFLOW DATA FOR INDIANA.
Geological Survey, Indianapolis, IN. Water Resources Div.
D. V. Arvin.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-62, 1989. 968p, 4 fig, 7 tab, 10 ref.

Descriptors: *Water resources data, *Stream discharge, *Indiana, *Data collections, *Streamflow data, Flow duration, High flow, Low flow, Annual means, Monthly means, Exceedance, Statistics.

Statistical analyses of daily mean discharge values collected at 229 Indiana streamflow-gaging stations are presented. For each station, data collected from the beginning of period of record through the 1985 water year were analyzed. Summaries include flow-duration, high-flow, and low-flow tables, and monthly and annual mean discharge. (USGS)
W90-02865

EVALUATION OF GRAPHITE FOR ENVIRONMENTAL TOXICITY USING THE STANDARD AQUATIC MICROCOSM.
Chemical Research and Development Center, Aberdeen Proving Ground, MD.
For primary bibliographic entry see Field 5C.
W90-02926

MAGNITUDE AND FREQUENCY OF PALAEOFLOODS.
Arizona Univ., Tucson. Dept. of Geosciences.
For primary bibliographic entry see Field 2E.
W90-02973

COMPUTATIONAL METHODS IN WATER RESOURCES: VOL. 1. MODELING SURFACE AND SUB-SURFACE FLOWS.
Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. Developments in Water Science, No. 35. 388p. Edited by M. A. Celia et al.

Descriptors: *Surface water, *Groundwater, *Mathematical models, *Flow, *Mathematical studies, *Computer models, Mathematical equations, Symposium, Surface-groundwater relations, Hydraulic models, Simulation.

This book forms part of the edited proceedings of the Seventh International Conference on Computational Methods in Water Resources, held at the Massachusetts Institute of Technology in June 1988. A wide variety of problems in surface and sub-surface hydrology are addressed, including: free surface flow modeling; vectorized programming issues for finite-element models; parameter identification and uncertainty analysis for variably saturated flow; modeling of highly advective flow problems; modeling of flow in porous media (saturated flow, unsaturated flow, multiphase flow, stochastic models, and saltwater intrusion); modeling of surface water flows (tidal models, lake and estuary models, and open-channel flow and sedimentation); and remote sensing and signal processing for hydrological modeling. (See W90-02981 thru W90-03035) (Rochester-PTT)
W90-02980

SOME EXAMPLES OF INTERACTION OF NUMERICAL AND PHYSICAL ASPECTS OF FREE SURFACE FLOW MODELLING.
CEFRHYG, Grenoble (France).
For primary bibliographic entry see Field 2E.
W90-02981

VECTORIZED PROGRAMMING ISSUES FOR FE MODELS.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
A. Peters.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 13-22, 7 fig, 26 ref.

Descriptors: *Computer programs, *Finite element method, *Supercomputers, *Path of pollutants, *Algorithms, *Groundwater movement, *Solute transport, Vector processing, Performance evaluation, Optimization, Path of pollutants.

Several programming issues are involved in the optimization of finite-element (FE) programs on supercomputers. Vector processing is the technique employed by most of the commercially available high-speed computers. Programming constructs are applied to the example of the FE solution of the irrotational ideal fluid flow equation. The system discussed is implemented on a Cray X-MP and a CDC-CYBER 205 and has been used to solve large-size problems of groundwater flow and contaminant transport through porous media. Topics covered are advanced computer architectures (algorithmic structures, vector processing, and degradation factors and remedies) and vectorization of FE programs (data structures and pre-processing, element matrices and the assemblage of the global matrix, and solution of the equations system). To obtain top performance from novel computer architectures, it is worth reconsidering the conventional approaches. New thinking is hampered because users have become accustomed to thinking in a scalar way. What needs to be vectorized is not the existing code, but the minds of the programmers. (See also W90-02980) (Rochester-PTT)
W90-02982

PARAMETER IDENTIFICATION AND UNCERTAINTY ANALYSIS FOR VARIABLY SATURATED FLOW.
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
J. F. Sykes, and N. R. Thomson.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 23-33, 5 fig, 2 tab, 10 ref.

Descriptors: *Ontario, *Groundwater movement, *Solute transport, *Parameterization, *Model studies, *Unsaturated flow, *Path of pollutants, *Algorithms, *Sanitary landfills, Lake Huron, Mathematical models, Uncertainty, Saturated flow, Hydraulic models, Computer programs, Statistics.

An integration is presented of conceptual model development, parameter optimization, and uncertainty analysis in the assessment of variably saturated groundwater flow in the vicinity of a sanitary landfill southwest of Midland, Ontario. At the site the regional topography slopes westward toward Nottawasaga Bay (southeast end of Lake Huron). Limestone bedrock occurs at approximately 90 m and the overburden consists of three major units: a lower till (40 m thick), a sand layer (36-40 m thick), and a localized deposit of silt, clay, and till. For remedial investigation and landfill studies, the more computationally feasible choice for the uncertainty analysis is the first and second moment method based on Taylor series expansion. A version of this technique is demonstrated here for determination of traveltime uncertainty in variability saturated groundwater flow. The uncertainty calculation provided by the developed moment method is based on the adjoint operator technique and is validated using the Latin hypercube method. Only Type II uncertainty resulting from employing the correct model with uncertain parameters is considered. The groundwater flow and solute migration model GWPGM3 is used for all optimization and uncertainty calculations. For direct sampling techniques such as the Latin hypercube method, the use of large standard deviations can result in the generation of physically unreasonable realizations. For both methods, the parameter standard deviations should be small; the moment methods require this for computational reasons whereas the direct parameter sampling methods require it for physical reasons. When the parameter standard deviations are small, the two methods compared quite favorably, but the computational burdens differ significantly. (See also W90-02980) (Rochester-PTT)
W90-02983

MODELING OF HIGHLY ADVECTIVE FLOW PROBLEMS.
Rice Univ., Houston, TX. Dept. of Mathematical Sciences.
M. F. Wheeler.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 35-44, 37 ref.

Descriptors: *Numerical analysis, *Model studies, *Path of pollutants, *Groundwater movement, *Advection, *Computer models, Algorithms, Diffusion, Chemical reactions, Biodegradation, Microorganisms, Fate of pollutants, Hydrocarbons, Performance evaluation.

Numerical methods appropriate for the modeling of highly advective flow problems are considered, with emphasis on fruitful approaches for emerging parallel computer architecture. Among these approaches are operator splitting and domain decomposition techniques. Discretization by operator splitting is emphasized because such an approach provides a computationally efficient way of decoupling various difficulties, namely advection, diffusion, reaction, incompressibility, and nonlinearities.

In operator time splitting, the spatial operator is split into two or more terms, each of which is solved sequentially using a numerical technique particularly suited for that operator. Topics covered include: algorithms for the advection operator that are regarded as accurate, robust, and computationally efficient (e.g., a modified method of characteristics and several higher-order techniques developed recently for modeling gas dynamics problems); schemes for adding physical diffusion and dispersion; an operator-splitting algorithm for microbial biodegradation of hydrocarbons in groundwater; and parallel computing considerations related to operator splitting, including an assessment of problems for which parallel computing is particularly appropriate. (See also W90-02980) (Rochester-PTT)
W90-02984

CROSS-BOREHOLE PACKER TESTS AS AN AID IN MODELLING GROUND-WATER RECHARGE.
Orange Free State Univ., Bloemfontein (South Africa). Inst. vir Grondwaterstudies.
For primary bibliographic entry see Field 7B.
W90-02985

BOUNDARY ELEMENT METHOD (GREEN FUNCTION SOLUTION) FOR UNSTEADY FLOW TO A WELL SYSTEM IN A CONFINED AQUIFER.
Nanjing Univ. (China). Dept. of Mathematics.
C.-H. Xie, and X.-Y. Zhu.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 53-58, 3 fig, 3 ref.

Descriptors: *Boundary conditions, *Unsteady flow, *Wells, *Confined aquifers, *Groundwater movement, *Mathematical equations, Green functions, Boundary element method, Performance evaluation, Comparison studies.

Equations for both the unsteady state and flow to a well system using the boundary element method (BEM) (Green function solution). The boundary integral formulation of the problem can be derived from Green's second identity. The problem is solved in a series of time steps in which the results of one time step become the initial conditions for the next time step. Using an example consisting of a 4 x 4 sq km square, the results of the BEM are compared with an analytic (Theis) solution. Good agreement was found between the two methods. (See also W90-02980) (Rochester-PTT)
W90-02986

FINITE ELEMENT SOLUTION OF GROUND-WATER FLOW PROBLEMS BY LANCZOS ALGORITHM.
Universidade Federal do Rio de Janeiro (Brazil). Coordenacao dos Programas de Pos-graduacao de Engenharia.
For primary bibliographic entry see Field 2F.
W90-02987

FINITE ELEMENT MODEL OF FRACTURE FLOW.
Notre Dame Univ., IN. Dept. of Civil Engineering.
R. Deuell, I. P. E. Kinnmark, and S. Silliman.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 65-70, 3 fig, 2 ref.

Descriptors: *Statistical models, *Fracture permeability, *Groundwater movement, *Geologic fractures, *Numerical analysis, *Finite element method, Simulation, Hydraulic models, Hydraulic roughness, Hydraulic geometry, Model testing.

Fracture variation in the direction of flow is examined in relation to two questions: (1) at what scale variations in fracture aperture exhibit characteristics associated with roughness and at what point these variations exhibit characteristics associated with non-parallel fracture walls and (2) when fracture walls are non-parallel, what is the appropriate value for use in the cubic law. To answer these questions, different fracture wall geometries were envisioned, symmetric perpendicular to flow and repeating parallel to flow. Only a triangular-shaped boundary is considered here. Numerical simulation made it possible to better characterize the flow in fractures where the aperture varies in the direction of flow. For flow governed by non-parallel plate behavior, flow is predicted by the cubic law, using the harmonic mean of the aperture cubed. This type of flow is present when the ratio of the length of the aperture change to the magnitude of aperture change is greater than 10; it is completely established when this ratio is 100 or larger. (See also W90-02980) (Rochester-PTT)
W90-02988

FINITE ELEMENT MODELING OF THE RURSCHOLLE MULTI-AQUIFER GROUND-WATER SYSTEM.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
For primary bibliographic entry see Field 2F.
W90-02989

COMPUTATION OF FLOW THROUGH A COMPOSITE POROUS DOMAIN.
Pretoria Univ. (South Africa). Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 2F.
W90-02990

TWO PERTURBATION BOUNDARY ELEMENT CODES FOR STEADY GROUNDWATER FLOW IN HETEROGENEOUS AQUIFERS.
Lagos Univ. (Nigeria). Hydraulic Research Unit.
O. E. Lafe, O. Owoputi, and A. H.-D. Cheng.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 83-88, 4 fig, 6 ref.

Descriptors: *Boundary conditions, *Computer programs, *Steady flow, *Aquifer characteristics, *Groundwater movement, Boundary element method, Hydraulic conductivity, Performance evaluation, Comparison studies, Heterogeneity, Data requirements.

Two boundary element method (BEM) codes are described that are aimed at circumventing the convergence problems of the original formulation. The first method adheres to the earlier formulation, but incorporates a zoning concept. This permits the use of slow-varying functions for the hydraulic conductivity within each zone while the variability throughout the entire flow field is large. The numerical process involves domain integrations. In the second method, the fundamental solution is perturbed into an asymptotic series. The solution process neither requires domain integration nor any iteration. The main difficulty with the second approach is that the Green's function is difficult to derive for an arbitrarily prescribed heterogeneity. It is proposed here that zones be combined with the use of simple hydraulic conductivity fields for which the fundamental solution can be constructed more readily. The result is an efficient BEM code for aquifers exhibiting complex heterogeneity. In addition, data preparation is eased when the present codes are used and, in cases where area integrations are required, the area elements are generated automatically from the boundary elements. (See also W90-02980) (Rochester-PTT)
W90-02991

THREE-DIMENSIONAL FINITE ELEMENT-FINITE DIFFERENCE MODEL FOR SIMU-

LATING CONFINED AND UNCONFINED GROUNDWATER FLOW.
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 2F.
W90-02992

GALERKIN FINITE ELEMENT MODEL TO SIMULATE THE RESPONSE OF MULTILAYER AQUIFERS WHEN SUBJECTED TO PUMPING STRESSES.
Florida Inst. of Tech., Melbourne. Dept. of Civil Engineering.
A. Pandit, and J. Abi-Aoun.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 95-100, 2 fig, 2 tab, 3 ref.

Descriptors: *Statistical models, *Model studies, *Groundwater movement, *Aquifers, *Pumping, *Hydrologic models, *Finite element method, *Galerkin method, Mathematical models, Simulation, Comparison studies, Wells, Mathematical analysis, Numerical analysis, Aquitards.

A finite-element model is introduced that can solve many types of complex radial-flow problems. Six example problems were used to check the accuracy of the model by comparing the results with available analytical and numerical results. An effort was made to check the effect of selected mesh sizes. The concept of effective radius was used to increase the computational efficiency of the model. The six example problems modeled were: (1) flow to a fully-penetrating well in a homogeneous and isotropic confined aquifer; (2) flow to fully-penetrating well in a dual-permeability confined aquifer; (3) flow to a partially-penetrating well in a homogeneous confined aquifer; (4) flow to a partially-penetrating well in a dual-permeability confined aquifer; (5) flow to a fully-penetrating well in a three-layer system consisting of two confined aquifers separated by an aquitard; and (6) flow to a fully-penetrating well with multiple screens of different mesh sizes. In all cases the medium was assumed to be isotropic. The solutions to these cases compared as expected with analytical or numerical solutions. (See also W90-02980) (Rochester-PTT)
W90-02993

FINITE ELEMENT BASED MULTI LAYER MODEL OF THE 'HEIDE TROUGH' GROUNDWATER BASIN.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
For primary bibliographic entry see Field 2F.
W90-02994

THREE-DIMENSIONAL FINITE ELEMENT GROUNDWATER MODEL FOR THE RIVER RHINE RESERVOIR KEHL/STRASBOURG.
Lahmeyer International G.m.b.H., Frankfurt am Main (Germany, F.R.).
W. Pelka, H. Arlt, and R. Horst.
IN: Computational Methods in Water Resources: Vol. 1. Modeling Surface and Sub-Surface Flows: Proceedings of the VII International Conference on Computational Methods in Water Resources, Massachusetts Institute of Technology, Cambridge, MA, June 1988. Elsevier, Amsterdam, and Computational Mechanics Publications, Southampton (co-publishers). 1988. p 107-112, 4 fig, 3 ref.

Descriptors: *Statistical models, *Model studies, *Groundwater movement, *Hydrologic models, *Finite element method, *West Germany, *Reservoirs, Dikes, Diaphragm walls, Groundwater movement, Water level, Economic aspects, Detention reservoirs, Rhine River, Reservoir design.

A mathematical model was developed for optimizing the depth of diaphragm walls in dikes along the River Rhine reservoir Kehl/Strasbourg and the model was implemented using a three-dimensional finite-element groundwater flow model and a finite-element channel flow model. The diaphragm walls are intended to prevent excessive rise in groundwater in nearby villages during the retention process. Several kilometers of diaphragm walls penetrating the dikes and the aquifer had to be planned. For a given length the depth of the diaphragm wall is the most significant cost factor. The geological profile involves several horizontal layers of gravel and silt, with differing permeabilities. The water level in the retention area was simulated when raised to the maximum operation level of the retention basins. Starting from this reference run (diaphragm depth = 0), the depth of the diaphragm was increased. To maintain the desired water level depth in the villages for each diaphragm depth, the cross-sections and slope of the drainage system had to be increased to a certain extent and several pump stations of varying capacity were required. The costs of the expansion and correction of the drainage system were compared with the costs of the related diaphragm wall. An optimum depth was defined that satisfied economic as well as environmental and safety requirements. (See also W90-02980) (Rochester-PTT)
W90-02995

ALTERNATING DIRECTION GALERKIN METHOD COMBINED WITH CHARACTERISTIC TECHNIQUE FOR MODELLING OF SATURATED-UNSATURATED SOLUTE TRANSPORT.
Fuzhou Univ. (China). Dept. of Geology and Mining Engineering.
For primary bibliographic entry see Field 2F.
W90-02996

SUBREGION BLOCK ITERATION TO 3-D FINITE ELEMENT MODELING OF SUBSURFACE FLOW.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 2F.
W90-02999

NUMERICAL SIMULATION OF DIFFUSION RATE OF CRUDE OIL PARTICLES INTO WAVE PASSES WATER REGIME.
Rivers State Univ. of Science and Technology, Port Harcourt (Nigeria). Dept. of Chemical and Petrochemical Engineering.
For primary bibliographic entry see Field 5B.
W90-03000

HIGH-RESOLUTION FINITE DIFFERENCE SIMULATOR FOR 3D UNSATURATED FLOW IN HETEROGENEOUS MEDIA.
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
For primary bibliographic entry see Field 2G.
W90-03004

SOLVING STOCHASTIC GROUNDWATER PROBLEMS USING SENSITIVITY THEORY AND HERMITE INTERPOLATING POLYNOMIALS.
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
For primary bibliographic entry see Field 2F.
W90-03005

COMPARISON OF NUMERICAL SOLUTION TECHNIQUES FOR THE STOCHASTIC ANALYSIS OF NONSTATIONARY, TRANSIENT, SUBSURFACE MASS TRANSPORT.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-03007

MODELLING FLOW IN HETEROGENEOUS AQUIFERS: IDENTIFICATION OF THE IMPORTANT SCALES OF VARIABILITY.

Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2F.
W90-03008

MODELLING OF SEA WATER INTRUSION OF LAYERED COASTAL AQUIFER.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
For primary bibliographic entry see Field 2F.
W90-03009

COMPARISON OF COUPLED FRESHWATER-SALTWATER SHARP-INTERFACE AND CONVECTIVE-DISPERSIVE MODELS OF SALTWATER INTRUSION IN A LAYERED AQUIFER SYSTEM.
Geological Survey, Lakewood, CO.
For primary bibliographic entry see Field 2F.
W90-03010

CAN THE SHARP INTERFACE SALT-WATER MODEL CAPTURE TRANSIENT BEHAVIOR.
Princeton Univ., NJ. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-03011

CONSISTENCY ANALYSIS OF THE FEM: APPLICATION TO PRIMITIVE AND WAVE EQUATIONS.
Princeton Univ., NJ. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03012

COMPARISON OF TIDAL MODELS FOR THE SOUTHWEST COAST OF VANCOUVER ISLAND.
Institute of Ocean Sciences, Sidney (British Columbia).
For primary bibliographic entry see Field 2L.
W90-03013

LONG TERM SIMULATION AND HARMONIC ANALYSIS OF NORTH SEA/ENGLISH CHANNEL TIDES.
Thayer School of Engineering, Hanover, NH.
For primary bibliographic entry see Field 2L.
W90-03017

TIDAL MOTION IN THE ENGLISH CHANNEL AND SOUTHERN NORTH SEA: COMPARISON OF VARIOUS OBSERVATIONAL AND MODEL RESULTS.
Liege Univ. (Belgium). Inst. de Mathematique.
For primary bibliographic entry see Field 2L.
W90-03018

EXPERIMENTS ON THE GENERATION OF TIDAL HARMONICS.
Geological Survey, Tacoma, WA.
For primary bibliographic entry see Field 2L.
W90-03019

2D MODEL FOR TIDAL FLOW COMPUTATIONS.
Katholieke Univ. Leuven (Belgium). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W90-03020

COUPLED FINITE DIFFERENCE-FLUID ELEMENT TRACKING METHOD FOR MODELLING HORIZONTAL TRANSPORT IN SHALLOW LAKES.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 2H.
W90-03021

HYDRODYNAMICS AND WATER QUALITY MODELING OF A WET DETENTION POND.

Virginia Univ., Charlottesville. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-03022

SYSTEM IDENTIFICATION AND SIMULATION OF CHESAPEAKE BAY AND DELAWARE BAY CANAL HYDRAULIC BEHAVIOR.
Maryland Dept. of Natural Resources, Annapolis.
For primary bibliographic entry see Field 2L.
W90-03025

LAYERED WAVE EQUATION MODEL FOR THERMALLY STRATIFIED FLOW.
Vermont Univ., Burlington. Dept. of Civil and Mechanical Engineering.
For primary bibliographic entry see Field 2H.
W90-03026

SIMPLE STAGGERED FINITE ELEMENT SCHEME FOR SIMULATION OF SHALLOW WATER FREE SURFACE FLOWS.
Iceland Univ., Reykjavik. Science Inst.
For primary bibliographic entry see Field 2H.
W90-03027

IMPROVED STABILITY OF THE 'CAFE' CIRCULATION MODEL.
National Technical Univ., Athens (Greece). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W90-03028

IMPLICIT FACTORED SCHEME FOR THE SIMULATION OF ONE-DIMENSIONAL FREE SURFACE FLOW.
Mexican Inst. of Water Technology, Jiutepec.
For primary bibliographic entry see Field 2E.
W90-03029

PRACTICAL ASPECTS FOR THE APPLICATION OF THE DIFFUSION-CONVECTION THEORY FOR SEDIMENT TRANSPORT IN TURBULENT FLOWS.
Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.).
For primary bibliographic entry see Field 2J.
W90-03030

COMPUTING 2-D UNSTEADY OPEN-CHANNEL FLOW BY FINITE-VOLUME METHOD.
Demokritos Univ. of Thrace, Xanthi (Greece). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03031

EULERIAN-LAGRANGIAN LINKED ALGORITHM FOR SIMULATING DISCONTINUOUS OPEN CHANNEL FLOWS.
Inland Waters Directorate, Burlington (Ontario).
For primary bibliographic entry see Field 2E.
W90-03032

COMPUTATIONAL METHODS IN WATER RESOURCES, VOL.2: NUMERICAL METHODS FOR TRANSPORT AND HYDROLOGIC PROCESSES.
For primary bibliographic entry see Field 2A.
W90-03036

STABILITY ANALYSIS OF DISCRETE APPROXIMATIONS OF THE ADVECTION-DIFFUSION EQUATION THROUGH THE USE OF AN ORDINARY DIFFERENTIAL EQUATION ANALOGY.
Mexican Inst. of Water Technology, Jiutepec.
For primary bibliographic entry see Field 2F.
W90-03037

SOLUTION OF THE ADVECTION-DIFFUSION EQUATION USING THE TOTAL DERIVATIVE AND LEAST SQUARES COLLOCATION.
Princeton Univ., NJ. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-03038

ANALYSIS OF SOME CLASSES OF PETROV-GALERKIN AND OPTIMAL TEST FUNCTION METHODS.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-03039

CELL ANALYTIC-NUMERICAL METHOD FOR SOLUTION OF THE TWO-DIMENSIONAL ADVECTION-DISPERSION EQUATION.
Illinois Univ. at Urbana-Champaign. Dept. of Nuclear Engineering.
For primary bibliographic entry see Field 2F.
W90-03040

FINITE ELEMENT TECHNIQUES FOR CONVECTIVE-DISPERSIVE TRANSPORT IN POROUS MEDIA.
Wyoming Univ., Laramie. Dept. of Mathematics.
For primary bibliographic entry see Field 2F.
W90-03041

3-D FINITE ELEMENT TRANSPORT MODELS BY UPWIND PRECONDITIONED CONJUGATE GRADIENTS.
Padua Univ. (Italy). Inst. of Applied Mathematics.
For primary bibliographic entry see Field 5B.
W90-03042

STRUCTURE OF MASS-RESPONSE FUNCTIONS OF DISSOLVED SPECIES IN HYDROLOGIC TRANSPORT VOLUMES.
Trento Univ. (Italy). Dept. of Engineering.
For primary bibliographic entry see Field 5B.
W90-03043

ADVECTION CONTROL METHOD FOR THE SOLUTION OF ADVECTION-DISPERSION EQUATIONS.
Shandong Univ., Jinan (China).
For primary bibliographic entry see Field 2F.
W90-03044

NON-DIFFUSIVE N+2 DEGREE UPWINDING METHODS FOR THE FINITE ELEMENT SOLUTION OF THE TIME DEPENDENT TRANSPORT EQUATION.
Texas A and M Univ., College Station. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-03045

CHARACTERISTIC ALTERNATING DIRECTION IMPLICIT SCHEME FOR THE ADVECTION-DISPERSION EQUATION.
Nanjing Univ. (China). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-03046

ZOOMABLE AND ADAPTABLE HIDDEN FINE-MESH APPROACH TO SOLVING ADVECTION-DISPERSION EQUATIONS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 2F.
W90-03047

TAYLOR WEAK STATEMENT CFD ALGORITHM FOR FREE SURFACE HYDROMECHANICAL FLOWS.
Tennessee Univ., Knoxville.
For primary bibliographic entry see Field 2E.
W90-03048

NUMERICAL SIMULATION OF THE VORTEX SHEDDING PROCESS PAST A CIRCULAR CYLINDER.
For primary bibliographic entry see Field 2E.
W90-03049

NUMERICAL INVESTIGATION OF TURBULENT FLOW FIELD IN A CURVED DUCT WITH AN ALTERNATING PRESSURE DIFFERENCE SCHEME.
Xian Jiaotong Univ. (China). Dept. of Power Mechanical Engineering.
For primary bibliographic entry see Field 8B.
W90-03050

TURBULENT DIFFUSION SIMULATION BY IMPLICIT FACTORED SOLVER USING K-EPSILON MODEL.
Florence Univ. (Italy). Dept. of Energy Engineering.
For primary bibliographic entry see Field 5B.
W90-03051

BOUNDARY ELEMENT INVESTIGATION OF NATURAL CONVECTION PROBLEMS.
Shinshu Univ., Matsumoto (Japan). Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 8B.
W90-03052

NEW FAMILY OF SHAPE FUNCTIONS.
Mississippi Univ., University. Dept. of Mechanical Engineering.
S. E. Adeff.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 117-122, 4 fig, 2 ref.

Descriptors: *Mathematical studies, *Hydraulics, *Estuarine hydraulics, *Chesapeake Bay, *Shape functions, *Finite element method, Surface water, Flow, Lagrangian functions, Navier-Stokes equations, Mathematical equations, Estuaries, Performance evaluation, Turbulent flow.

A new family of finite-element shape functions is presented that was constructed using sine and cosine functions. These functions can sustain an infinite order of derivatives. Unlike the Lagrangian family of shape functions, which requires the addition of new nodes as the order of derivatives to be represented grows, the present family is indifferent to this requirement. Consequently, for the one-dimensional (1-D) subset, it is restricted, for the sake of simplicity and economy, to two members. By obtaining products of 1-D functions, the 2-D and 3-D subsets are obtained in the same way that the corresponding Lagrangian functions are built. Although second derivatives appearing in the viscosity terms in the Navier-Stokes equations can be reduced to first order derivatives through integration by parts, techniques such as the Dendy version of Petrov-Galerkin weighting and the Taylor-Galerkin procedure avoid the need for computing second derivatives. A quadratic Lagrangian function renders constant second derivatives, not allowing enough flexibility to efficiently represent the actual gradients involved. The new functions totally overcome deficiencies of this type and possess greater generality. Possible economic disadvantages of lower-order derivative cases are overcome easily by tabulating the function values at fixed local abscissas. An application to the simple problem of a depth-integrated inviscid fluid flow in upper Chesapeake Bay is presented. The solution obtained from this example is indistinguishable from that resulting from using the Lagrangian family. Three-dimensional and depth-integrated turbulent flow problems are being solved currently. (See also W90-03036) (Author's abstract)
W90-03053

ADAPTIVE COLLOCATION FOR BURGERS' EQUATION.
Wyoming Univ., Laramie.
For primary bibliographic entry see Field 8B.
W90-03054

ALTERNATIVE WAYS OF TREATING DOMAIN INTEGRALS IN BOUNDARY ELEMENTS.
Southampton Univ. (England). Computational Mechanics Inst.
C. A. Brebbia.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 129-138, 3 fig, 15 ref.

Descriptors: *Mathematical studies, *Fluid flow, *Boundary element method, Mathematical equations, Domain integrals, Computation, Finite element method, Dual reciprocity method, Groundwater movement, Stream discharge, Soil water, Hydrodynamics.

Alternative techniques are considered for treating domain type integrals of the type found in many boundary element problems. These integrals may originate in body forces distributed through the domain, nonlinear effects, or initial conditions in the case of time-dependent problems. The success of the boundary element method (BEM) as a generalized numerical technique rests to a large degree on its computationally efficient treatment of domain integrals. The prevalent existing technique of discretizing the domain into cells destroys a large part of the advantage of the BEM over finite-element methods (FEM). A new approach, the dual reciprocity method (DRM), is presented that preserves the inherent advantage of the BEM, that is, working with unknowns and integrals on the boundary only. The DRM provides a general technique for transforming the BEM domain integrals into boundary integrals. The DRM approach is extended here to deal with distributed forces acting only on part of the domain and particularly to the case of triangular subdomains. The choice of functions for axisymmetric, two-dimensional and three-dimensional applications also is discussed. Although the DRM was developed originally for elastodynamics, it has been applied to solve potential and fluid flow problems and has a wide range of applications in water resources. (See also W90-03036) (Rochester-PTT)
W90-03055

ADVANCES ON THE NUMERICAL SIMULATION OF STEEP FRONTS.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Geofisica.
For primary bibliographic entry see Field 2F.
W90-03056

GUIDELINES FOR THE USE OF PRECONDITIONED CONJUGATE GRADIENTS IN SOLVING DISCRETIZED POTENTIAL FLOW PROBLEMS.
Dienst Grondwaterverkenning TNO, Delft (Netherlands).
For primary bibliographic entry see Field 2F.
W90-03057

NON LINEAR INSTABILITY IN LONG TIME CALCULATIONS OF A PARTIAL DIFFERENCE EQUATION.
Dundee Univ. (Scotland). Dept. of Mathematics and Computer Science.
A. R. Mitchell.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 153-160, 13 ref.

Descriptors: *Mathematical studies, *Hydrologic models, *Mathematical equations, *Nonlinear instability, Mathematical equations, Differential equations, Mathematical models, Numerical analysis, Comparison studies.

The stability of long time (t to infinity) calculations of nonlinear partial difference equations is examined. The model chosen is a discretisection in space and time of the Korteweg de Vries equation. The standard linearized von Neumann stability analysis, although necessary, is not sufficient, because it ignores the quadratic nature of the nonlinearity in

the problem. Nonlinear stability is analyzed by perturbing a constant solution with a period 3 Fourier mode. This leads to a nonlinear system of ordinary differential equations, the stability of which is examined by phase plane analysis. The results obtained contrast strongly with those obtained from the linear analysis. A numerical illustration shows how a single Fourier mode initial condition, through side band growth, eventually causes blow-up in a long-duration calculation. (See also W90-03036) (Author's abstract)
W90-03058

NUMERICAL TREATMENT OF PARTIAL DIF-FERENTIAL EQUATIONS BY THE PARAL-LEL APPLICATION OF A HYBRID OF THE RITZ-, GALERKIN-PRODUCT INTEGRAL METHODS.
Wisconsin Univ.-Green Bay. Dept. of Mathematics.
N. L. Petrakopoulos.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 161-166, 9 ref.

Descriptors: *Mathematical studies, *Mathematical equations, *Hydraulic models, *Volterra-Petra, *Galerkin Method, Navier-Stokes equations, Waves, Algorithms, Errors, Product integrals, Linear systems, Differential equations.

Recently the utility of the transcendental functions of matrices, and the multiplicative integral methods (Volterra-Petra) has been demonstrated for the simulation of systems modeled by ordinary differential equations and by the semi-discrete Navier-Stokes equations, which are derived from the exact Navier-Stokes equations using Galerkin methods. It has been demonstrated that the Volterra-Petra method is direct and simple to use from the point of view of the simulationist, notwithstanding the complexity of the key theoretical results that form the basis of the method. Here the utility is demonstrated of the Volterra-Petra method in the simulation of systems modelled by partial differential equations that are Staeckel-separable. LaPlace's equation, Poisson's equation, the diffusion equation, the wave equation, the damped wave equation, and the transmission line equation are examples of Staeckel-separable partial differential equations. The product integral algorithm is discussed. The product integral, an analogue to the sum integral for the ordinary integral, has as its limit the multiplicative integral of Volterra. The multiplicative integral algorithm has been tested on specific linear systems whose coefficients exhibited considerable variation. The numerical results obtained exhibited relative errors on the order of 0.000001 percent. (See also W90-03036) (Rochester-PTT)
W90-03059

FRACTIONAL STEPS AND PROCESS SPLIT-TING METHODS FOR INDUSTRIAL CODES.
CEFRHYG, Grenoble (France).
J. M. Usseglio-Polatera, and M. K. Chenin-Mordojovich.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 167-172, 17 ref.

Descriptors: *Mathematical studies, *Computer programs, *Process control, *Hydraulics, *Mathematical equations, Numerical analysis, Performance evaluation, Differential equations, Process-splitting, Waves, Momentum, Physics, Boundary conditions.

The method of fractional steps introduced by N. N. Yanenko is a remarkable and cost-efficient technique for computational mechanics. Among the various fractional step methods, process-splitting is particularly attractive for the two-dimensional (2-D) and three-dimensional (3-D) simulations in water resources. These methods were applied to various 2-D and 3-D industrial codes in the field of computational hydraulics. An attempt is made to define the state of the art and to establish the formal limitation of the method for 2-D shallow water applications. The differences in the numeri-

cal nature of the basic physical processes involved in the governing equations also influence boundary conditions requirements. Upstream conditions predominate for advection, leading to a polarization in the flow directions. Whatever the wave celerity, wave propagation or momentum diffusion do not create such a space polarization. Since the necessary boundary conditions are not the same, the process-splitting technique, which requires specific boundary conditions for each time step, should be advantageous. Conversely, since only the conditions corresponding to the complete differential equations are known, the treatment of boundary conditions is a major drawback to process-splitting as it is to every major fractional step technique. Despite unconditional stability, the maximum allowable time-step is constrained by the treatment of intermediate-level boundary conditions. Due to the lack of information, trade-offs are necessary and evaluation of the induced error is difficult. (See also W90-03036) (Rochester-PTT)
W90-03060

CONSTRUCTION OF N-TH ORDER FUNC-TIONS FOR COMPLETE INTERPOLATION.
Mississippi Univ., University. School of Engineering.
S. Y. Wang, K. K. Hu, P. G. Kramer, and S. E. Swartz.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 173-180, 5 fig, 5 ref. US Army Engineer Waterways Experiment Station Contract DACW 39-87-K0088, Mississippi Water Resources Research Institute Grant G1234-06, NSF Grant MSM-8513982.

Descriptors: *Mathematical studies, *Mathematical studies, *Shape functions, *Finite element method, *Interpolation, *Hydraulics, Mathematical equations, Spatial distribution, Integration, Algebraic equations.

A general methodology for constructing n-th order shape functions over two-dimensional (2-D) and (3-D) elements is presented. These shape functions are capable of accurately representing the physical phenomena modeled by the finite-element analysis. The development of this methodology and its application are given. The procedure is to construct complete elements of n-th order by modifying the interpolation functions of Taylor-Hermitian family in 1-, 2-, and 3-D space. The methodology can be applied to elements enclosed by polygonal areas. The interpolated results from complete elements should be smoother than those of incomplete Hermitian interpolation. The shape functions derived are in terms of the spatial coordinates without having to transform the element into some normalized spaces. This allows direct calculations of partial derivatives without the complication of the Jacobian matrices. It allows the numerical integration over the domain to be computed more efficiently. If collocation methods are used in the finite-element analysis, the use of this direct interpolation will be one of the most convenient ways to establish the algebraic equations. (See also W90-03036) (Rochester-PTT)
W90-03061

THREE-DIMENSIONAL ADAPTIVE EULER-IAN-LAGRANGIAN FINITE ELEMENT METHOD FOR ADVECTION-DISPERSION.
Nebraska Univ., Lincoln. Conservation and Survey Div.
For primary bibliographic entry see Field 2F.
W90-03062

COMPUTER MODELING OF GROUNDWAT-ER FLOW THROUGH POROUS MEDIA USING A MONTE-CARLO SIMULATION TECHNIQUE.
TGG Environmental, Inc., Needham, MA.
For primary bibliographic entry see Field 2F.
W90-03063

DISPERSION OF CONTAMINANTS IN SATU-RATED POROUS MEDIA: VALIDATION OF A FINITE-ELEMENT MODEL.

Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
For primary bibliographic entry see Field 5B.
W90-03064

MODELING WATER AND CONTAMINANT TRANSPORT IN UNCONFINED AQUIFERS.
Australian Nuclear Science and Technology Organisation, Sutherland. Environmental Science Div.
For primary bibliographic entry see Field 5B.
W90-03065

ACCURATE FINE-GRID SIMULATIONS TO DERIVE COARSE-GRID MODELS OF FINE-SCALE HETEROGENEITIES IN POROUS MEDIA.
Colorado Univ. at Denver. Dept. of Mathematics.
For primary bibliographic entry see Field 2F.
W90-03066

NUMERICAL EXPERIMENT WITH EULER-LAGRANGE METHOD FOR A PAIR OF RE-CHARGE-PUMPING WELLS.
Technion - Israel Inst. of Tech., Haifa. Faculty of Bio-Medical Engineering.
For primary bibliographic entry see Field 5B.
W90-03067

USE OF PARTICLE TRACKING METHODS FOR SOLUTE TRANSPORT IN POROUS MEDIA.
Lawrence Livermore National Lab., CA. Earth Sciences Dept.
For primary bibliographic entry see Field 5B.
W90-03068

SOLUTE TRANSPORT: EQUILIBRIUM VS NON-EQUILIBRIUM MODELS.
Pontificia Univ. Catolica de Chile, Santiago. Faculty of Engineering.
For primary bibliographic entry see Field 2G.
W90-03073

CONFRONTATIONS BETWEEN COMPUTER SIMULATIONS AND LABORATORY WORK TO UNDERSTAND MECHANISMS CONTROL-LING TRANSPORT OF MERCURY.
Strasbourg-1 Univ. (France). Inst. de Mechanique des Fluides.
For primary bibliographic entry see Field 5B.
W90-03074

QUICK ALGORITHM FOR THE DEAD-END PORE CONCEPT FOR MODELING LARGE-SCALE PROPAGATION PROCESSES IN GROUNDWATER.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
For primary bibliographic entry see Field 5B.
W90-03075

MULTICOMPONENT SOLUTE TRANSPORT WITH MOVING PRECIPITATION/DISSOLU-TION BOUNDARIES.
Notre Dame Univ., IN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-03077

ADVANTAGE OF HIGH-ORDER BASIS FUNC-TIONS FOR MODELING MULTICOMPON-ENT SORPTION KINETICS.
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 5D.
W90-03078

FINITE ELEMENT MODEL OF FREE CON-VECTION IN GEOLOGICAL POROUS STRUC-TURES.
LEPT-ENSAM, Esplanade des Arts et Metiers,

33405 Jalence, France.
For primary bibliographic entry see Field 2F.
W90-03079

RADIATIVE HEAT TRANSFER TO FLOW IN POROUS PIPE WITH CHEMICAL REACTION AND LINEAR AXIAL TEMPERATURE VARIATION.
International Centre for Theoretical Physics, Trieste (Italy).
For primary bibliographic entry see Field 8B.
W90-03080

VALIDATION OF FINITE ELEMENT SIMULATION OF THE HYDROTHERMAL BEHAVIOR OF AN ARTIFICIAL AQUIFER AGAINST FIELD PERFORMANCE.
Technische Hochschule Aachen (Germany, F.R.). Inst. fuer Wasserbau.
For primary bibliographic entry see Field 2F.
W90-03082

NUMERICAL MODELING OF HOT WATER STORAGE IN AQUIFER BY FINITE ELEMENT METHOD.
Ecole Nationale Superieure d'Arts et Metiers, Paris (France).
For primary bibliographic entry see Field 2F.
W90-03083

MODELLING THE REGIONAL HEAT BUDGET IN AQUIFERS.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie.
For primary bibliographic entry see Field 2F.
W90-03084

THERMAL ENERGY STORAGE MODEL FOR A CONFINED AQUIFER.
Nanjing Univ. (China). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-03085

NUMERICAL ANALYSIS OF TRANSIENTS IN COMPLEX HIDROPOWER SCHEME.
Eletrosul, Florianopolis (Brazil).
For primary bibliographic entry see Field 8B.
W90-03086

SOME ASPECTS OF KALMAN FILTERING APPLICATION IN HYDROLOGIC TIME SERIES PROCESSING.
Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
For primary bibliographic entry see Field 2E.
W90-03087

ADJOINT-STATE AND SENSITIVITY COEFFICIENT CALCULATION IN MULTILAYER AQUIFER SYSTEM.
Westinghouse Hanford Co., Richland, WA.
For primary bibliographic entry see Field 2F.
W90-03091

NUMERICAL ASPECTS OF SIMULATION AND OPTIMIZATION MODELS FOR A COMPLEX WATER RESOURCES SYSTEM CONTROL.
Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
For primary bibliographic entry see Field 3F.
W90-03093

OPTIMAL OPERATION OF A RESERVOIR SYSTEM WITH NETWORK FLOW ALGORITHM.
Universidade Estadual de Campinas (Brazil). Dept. de Engenharia de Sistemas.
For primary bibliographic entry see Field 4B.
W90-03094

OPTIMIZATION OF WATER QUALITY IN RIVER BASIN.
Bulgarian Academy of Sciences, Sofia. Inst. of Water Problems.
For primary bibliographic entry see Field 5G.
W90-03095

COUPLING OF UNSTEADY AND NONLINEAR GROUNDWATER FLOW COMPUTATIONS AND OPTIMIZATION METHODS.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
For primary bibliographic entry see Field 2F.
W90-03096

RELIABILITY CONSTRAINED MARKOV DECISION PROGRAMMING AND ITS PRACTICAL APPLICATION TO THE OPTIMIZATION OF MULTIPURPOSE RESERVOIR REGULATION.
Tsinghua Univ., Beijing (China). Dept. of Hydraulic Engineering.
For primary bibliographic entry see Field 4A.
W90-03097

OPTIMAL MULTIOBJECTIVE OPERATIONAL PLANNING OF A WATER RESOURCES SYSTEM.
Universidade Estadual de Campinas (Brazil). Dept. de Engenharia de Sistemas.
For primary bibliographic entry see Field 4A.
W90-03098

FLEXIBLE POLYHEDRON METHOD WITH MONOTONICITY ANALYSIS.
Zhejiang Univ., Hangzhou (China). Dept. of Civil Engineering.
S. Y. Wang, and Z. L. Chen.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 431-436, 3 fig, 1 tab, 2 ref.

Descriptors: *Model studies, *Reservoir design, *Water resources development, *Optimization, *Mathematical models, *Polyhedron method, *Algorithms, Monotonicity analysis, Irrigation, Management planning, Design criteria, Dam foundations, Comparison studies, Complex method, Mathematical models, Hydraulic engineering.

Direct search methods are widely used in for dealing with objective functions and constraints in engineering optimization, because these items are not always differentiable. The chief drawback of direct search methods is the slowness with which they converge. An algorithm is presented here that consists of the following parts: (1) pretreatment of a given problem through global monotonicity analysis to form a mathematical model that is equivalent to the problem by greatly simplified; (2) random generation of an initial polyhedron in the feasible region; (3) calculation of a weighted centroid and obtaining of a descent direction; (4 estimation of step-length for a new better point (vertex) using local monotonicity analysis around the centroid and reconstruction of a new polyhedron; and (5) using the gradient projection direction to further improve convergence of the algorithm at the final search stage. Steps 3-5 are emphasized in the present paper and the use of the method with two examples is described: (1) optimization of irrigation project planning and (2) optimum design of a concrete dam with broad joints. For the first problem, the number of iterations, objective function, and constraint evaluation were 137, 289, and 296, respectively, versus 254, 2351, and 716 for the simple complex method. For the second problem, the number of objective and constraint evaluation was about 490 and 608, respectively, versus 737 and 1202 for the complex method. (See also W90-03036) (Rochester-PTT)
W90-03099

SOFTWARE PACKAGE FOR THE COMPUTER AIDED DESIGN OF SEWER SYSTEMS.
Vrije Univ., Brussels (Belgium). Lab. of Hydrology.

For primary bibliographic entry see Field 5D.
W90-03100

INTERACTIVE DESIGN OF IRREGULAR TRIANGULAR GRIDS.
Institute of Ocean Sciences, Sidney (British Columbia).
For primary bibliographic entry see Field 2L.
W90-03101

FLOSA - 3FE: VELOCITY ORIENTED THREE-DIMENSIONAL FINITE ELEMENT SIMULATOR OF GROUNDWATER FLOW.
Politechnika Warszawska (Poland).
For primary bibliographic entry see Field 2F.
W90-03102

RELIABLE SYSTEM SOFTWARE FOR THE MICRO-PROCESSOR BASED HYDROMETEROLOGICAL NETWORK FOR REAL TIME STREAM FLOW AND FLOOD FORECASTING IN NARMADA BASIN IN INDIA.
Narmada Control Authority, Bhopal (India).
For primary bibliographic entry see Field 2E.
W90-03103

HYBRID SIMULATION FOR KARST WATER SYSTEMS--EXEMPLIFIED BY BEISHAN KARST WATER SYSTEMS.
Institute of Karst Geology, Guilin (China).
For primary bibliographic entry see Field 2F.
W90-03117

THRESHOLD AUTOREGRESSIVE MODEL APPLIED TO PREDICTION OF KARST SPRING FLOW.
Institute of Karst Geology, Guilin (China).
For primary bibliographic entry see Field 2F.
W90-03118

DISCRETE STATE COMPARTMENT MODEL AND ITS APPLICATION TO FLOW THROUGH KARSTIC AQUIFERS.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2F.
W90-03119

FISSURE-KARST WATER RESOURCE EVALUATION IN A WELL FIELD NEAR XUZHOU.
Nanjing Univ. (China).
For primary bibliographic entry see Field 2F.
W90-03121

ANALYSIS AND COMPARISON OF SOME VALUES OF TRANSMISSIVITY, PERMEABILITY AND STORAGE FROM THE EUGANEAN THERMAL BASIN.
Padua Univ. (Italy). Inst. of Geology.
For primary bibliographic entry see Field 2F.
W90-03123

AUTOMATIC TREATMENT OF PHOTOLINES.
Universidad del Pais Vasco, Bilbao (Spain). Dept. of Geodynamic.
R. Ramon-Lluch, and L. M. Martinez-Torres.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 759-761.

Descriptors: *Computer programs, *Photolines, *Karst, Fracture permeability, *Geohydrology, Karst hydrology, Geologic fractures.

In order to make photolines analysis easier in karsts, a program was formulated in BASIC, the main aim of which is: to calculate automatically the direction and length of photolines, assigning them to classes or families; and to determine the grade of fracture density relative to the number of

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line intersections per unit of area, and state this process by printed and graphic means. Data may be entered by using a light pen on a graphic display. Direction and length of the line and its x and y coordinates are calculated automatically. The data can be printed out as rosette diagrams, line drawings, or printer data. (See also W90-03104) (Lantz-PTT)
W90-03130

INVENTORY OF SINKHOLES AND RELATED KARST FEATURES IN THE COMMON-WEALTH OF PENNSYLVANIA, USA.
Pennsylvania Dept. of Environmental Resources, Harrisburg. Bureau of Topographic and Geologic Survey.
For primary bibliographic entry see Field 2F.
W90-03181

EVALUATION AND PREDICTION OF KARST COLLAPSE--AS EXEMPLIFIED BY THE DA-GUANGSHAN IRON MINE.
Institute of Karst Geology, Guilin (China).
S. Xiang, J. Chen, and Y. Qin.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1169-1177, 8 fig, 11 tab, 4 ref.

Descriptors: *Data interpretation, *Subsidence, *China, *Karst hydrology, *Mine drainage, *Geohydrology, Statistical analysis, Multivariate analysis, Quantitative analysis, Karst.

Karst collapse is a major geological hazard, representing a serious environmental geological problem in karst regions of China. Methods of quantitative evaluation and prediction of karst collapse have been studied only in recent years. This paper discusses the application of correlation analysis with single factor karst collapse, in combination with multivariate statistical methods based on geological qualitative analysis, to evaluate and predict karst collapse. The Daguangshan Iron Mine is used as an example. (See also W90-03104) (Author's abstract)
W90-03182

SOME EXPERIENCES IN COMPILING HYDROGEOLOGICAL MAPS OF KARSTIC TERRAINS IN CHINA.
Ministry of Geology and Mineral Resources, Beijing (China). Advisory Committee on Geology Science and Technology.
M. Chen.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1221-1228.

Descriptors: *Mapping, *Aquifer systems, *Maps, *China, *Karst hydrology, *Geohydrology, Karst, Hydrologic data collections, Groundwater storage, Classification.

Karst water, known as fissure-cavity water in carbonate formations, is well-developed in China. It is grouped separately as one of the basic types of aquifer system in regional geohydrological mapping. According to the different conditions where karst aquifers occur, it is classified into three types: (1) exposed, (2) covered, and (3) buried. Karst aquifers can also be divided into several sub-types based on their different lithological characteristics. In designing a map legend, karst water is assigned two or three basic colors, with different shades of color used to distinguish the degree of water storage capacity. The covered type and the buried type are expressed on a geohydrological map by the so-called 'dualistic method' to show the relationship between the karst aquifers and the overlying strata. In addition, recharge or discharge systems and other geohydrological features are also considered when compiling maps. (See also W90-03104) (Author's abstract)
W90-03188

HYDROGEOLOGICAL MAPPING AND THE USE OF REMOTE SENSING TECHNIQUE IN THE KARST AREAS OF BOHEMIAN MASSIF.
Ustredni Ustav Geologicky, Prague (Czechoslovakia).
Z. Hrkal.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1229-1231, 1 fig.

Descriptors: *Geohydrology, *Maps, *Czechoslovakia, *Karst hydrology, *Groundwater budget, *Remote sensing, *Mapping, Data interpretation, Aerial photography, Groundwater storage.

Geohydrological mapping on a 1:50,000-scale has been carried out in the Bohemian Massif in Czechoslovakia within the framework of environmental map sets. The main purpose of these maps is to show geohydrological characteristics from both a quantitative and qualitative point of view. a Investigations have focused on establishing the relationship between aerial photography lineaments and the yield of boreholes. More than 76 maps have been finished, covering half the territory of the Bohemian Massif. Results of statistical analysis shown on the maps are used to assess water resources. (See also W90-03104) (Author's abstract)
W90-03189

PROPOSAL OF A FORM FOR THE RECORD-ING OF THE MAIN KARST SPRINGS.
Padua Univ. (Italy). Dept. of Geography.
U. Sauro.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1237-1241.

Descriptors: *Data acquisition, *Data interpretation, *Karst hydrology, *Springs, *Hydrologic data collections, Karst, Groundwater budget.

An outline of a form which could be used to record the main karst springs of different countries is presented. The aim of the form is to collect, in a systematic way, data on the main karst springs of the World, considering them from both the hydrological and geomorphological point of view, with respect to the impact of man. The form gives an opportunity for the proposal of an organic project of recording karst sources to acquire knowledge which can be used to compare the hydrology of the main karst areas. Such knowledge is also useful to administrators, who can then better manage karst water resources and their surroundings. (See also W90-03104) (Lantz-PTT)
W90-03191

ANALYSIS OF TRENDS IN THE HYDROGEO-LOGIC CARTOGRAPHY OF KARSTIC TER-RAINS.
Zagreb Univ. (Yugoslavia). Inst. of Geology.
A. Sarin.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1242-1249, 17 ref.

Descriptors: *Mapping, *Maps, *Geohydrology, *Karst hydrology, Hydrologic data collections, Data interpretation, Groundwater budget, Karst.

Among the numerous types of geohydrologic maps that have been made to date, five stand out for either their initial or valuable presentation of geohydrologic features of karstic terrains, and/or their importance in global geohydrologic cartography. They are: maps of France, the international map of Europe, the map of the Nord-Montpellier karstic region, the map of Venezuela, and the map of Croatia. The author, who has during the last two decades devoted a great part of his professional work to geohydrologic cartography, expresses his reflections and recommendations on this topic. He

strongly recommends the following when constructing a geohydrologic map of areas containing a karstic terrain: (1) a special color for karstic terrain; (2) the use of a number of symbols for different types of individual karst phenomena; and (3) the inclusion of special data in accompanying marginal small-scale maps, such as depth to groundwater. (See also W90-03104) (Lantz-PTT)
W90-03192

SURFACE AND SUBSURFACE MAPPING IN HYDROGEOLOGY.
M. Erdelyi, and J. Galfi.
John Wiley and Sons, New York, NY. 1988. 384p.

Descriptors: *Geologic mapping, *Subsurface mapping, *Geohydrology, *Mapping, Metamorphic rocks, Remote sensing, Geophysics, Geothermal studies, Water chemistry, Geologic formations.

An enormous variety of geohydrological formations ocur in nature, creating a great diversity of mapping prpoblems. In spite of this situation, some structures of geohydrological formations are more or less common throughout the world, and can be selected and mapped by well-defined geohydrological mapping methods. This book was written to cover all aspects of surface and subsurface geohydrological engineering and environmental protection mapping, applying methods of remote sensing (including photogeology), geophysics (surface and borehole), geothermics and water chemistry. Mapping methods are discussed in separate chapters. Each chapter deals with a well-defined geological structure (environment), including: quality of groundwater; crystalline and metamorphic rocks; volcanic rock areas; sedimentary areas; carbonate rock terrains; river valleys; and sedimentary lowlands. (Lantz-PTT)
W90-03199

RAINFALL-RUNOFF TRANSFER FUNCTION BY ARMA MODELING.
Marquette Univ., Milwaukee, WI. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03223

STEP-DRAWDOWN DATA ANALYSIS.
National Chiao Tung Univ., Hsinchu (Taiwan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-03226

LABORATORY MODELS FOR ASSESSING THE FATE OF GROUNDWATER CONTAMI-NANTS.
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
For primary bibliographic entry see Field 5B.
W90-03244

CONSTRAINED MEDIAN STATISTICAL ROUTING METHOD AND THE PECOS RIVER CASE.
Texas Univ. at Austin. Center for Cybernetic Studies.
For primary bibliographic entry see Field 6D.
W90-03321

INTERFACIAL MIXING IN STRATIFIED CHANNEL FLOWS.
Nebraska Univ.-Lincoln. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W90-03331

NUMERICAL ESTIMATION OF AQUIFER PA-RAMETERS USING TWO OBSERVATIONAL WELLS.
Obafemi Awolowo Univ., Ile-Ife (Nigeria). Dept. of Geology.
O. Ajayi, and T. O. Obilade.
Journal of Hydraulic Engineering (ASCE)

JHEND8, Vol. 115, No. 7, p 982-988, July 1989. 7 ref.

Descriptors: *Aquifer characteristics, *Well capacity, *Pumping tests, *Groundwater movement, Transmissivity, Drawdown, Data processing, Computer programs, Finite difference methods, Estimating equations, Well data.

Estimation of the aquifer parameters transmissivity, T, and storativity, S, has been based historically on grapho-analytical techniques of artful curve matching and curve-fitting. Attempts have also been made to eliminate the visual judgment involved in grapho-analytical techniques for better accuracy. However, these methods still require considerable judgment on the part of the analyst in the selection of lines of best fit or consultation and interpolation of tabulated values of well functions. A numerical scheme for obtaining estimates of T and S directly from pumping test data without the need for curve matching, curve fitting or reference to tables is presented following a procedure of Rai, T and S derived from drawdown data at a given time from two observational wells located at given radial distances from the axis of the pumped well. A finite difference scheme was used to find a numerical solution directly from the pumping test data; a formula for a derived well function was iterated to eliminate the need to refer to well function tables, and the determination of T and S directly from pumping test data was fully automated. This method is applicable to both late time and early time data, and the scheme is amenable to real-time determination of T and S directly on-site using portable computers. (Ence-PTT)
W90-03338

SOFTWARE FOR INTEGRATED DAM MONITORING SYSTEMS.
Coyne et Bellier, Paris (France). Dams and Hydraulics Dept.
For primary bibliographic entry see Field 8G.
W90-03387

ESTIMATING PROBABILITIES OF EXTREME RAINFALLS.
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2B.
W90-03399

RISK ESTIMATION IN PARTIAL DURATION SERIES.
Technical Univ. of Denmark, Lyngby. Inst. of Hydrodynamics and Hydraulic Engineering.
For primary bibliographic entry see Field 2E.
W90-03420

APPROXIMATE ALTITUDE OF WATER LEVELS IN WELLS IN THE CHICOT AND EVANGELINE AQUIFERS IN THE HOUSTON AREA, TEXAS, SPRING 1989.
Geological Survey, Austin, TX. Water Resources Div.
D. L. Barbie, L. S. Coplin, and C. W. Bonnet.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-237, 1989. 2 fig, 1 ref.

Descriptors: *Potentiometric level, *Coastal aquifers, *Texas, *Water level, *Groundwater data, Subsidence, Maps.

This report shows the altitudes of water levels in the Chicot and Evangeline aquifers in the Houston metropolitan area, Texas. Of the 425 wells measured, 307 were used to construct the maps of potentiometric surface. The Chicot and Evangeline aquifers are composed of several sand layers, each with a separate potentiometric surface. These maps, however, show a single potentiometric surface which represents the collective water levels for the sand layers comprising each aquifer. (USGS)
W90-03539

SUMMARY OF HYDROLOGIC DATA FOR THE SAN GABRIEL RIVER BASIN AND ED-

WARDS AQUIFER, GEORGETOWN AREA, TEXAS, WATER YEAR 1988.
Geological Survey, Austin, TX. Water Resources Div.
L. F. Land, and M. E. Dorsey.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-226, 1989. 1 sheet, 5 fig, 2 tab, 3 ref.

Descriptors: *Groundwater level, *Groundwater data, *Texas, *San Gabriel River, *Edwards aquifer, *Water resources data, Streamflow, Data collections, Maps.

The Geological Survey's water resource monitoring program in the Georgetown area, Texas for water year 1988 consisted of a network of about 65 observation wells measured in the winter and summer, and a network of 10 streamflow-monitoring sites where flow was measured either continually or in the winter and summer. Data measurements included flow or water levels, specific conductance, temperature, and pH. These data show that the streamflow was substantially less in water year 1988 than in the previous 2 years. Regional changes in groundwater levels between the winters of 1987 and 1988 show slight declines (2 to 6 ft) in the northeast part of the study area while moderate declines (6 to 10 ft) were common in the southeast part. The most severe declines (greater than 10 ft) occurred in the corridor between Round Rock and Georgetown. A pattern of greater declines (moderate to severe) than in the surrounding area occurred north of Georgetown. (USGS)
W90-03541

GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1989.
Geological Survey, Salt Lake City, UT. Water Resources Div.
C. B. Burden.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-240, 1989. 83p, 43 fig, 3 tab, 3 ref.

Descriptors: *Groundwater data, *Water resources data, *Utah, Data collections, Hydrologic data.

This report contains information on well construction, groundwater withdrawals from wells, water level changes, and related changes in precipitation and streamflow in Utah. Supplementary data such as graphs showing chemical quality of water and maps showing water level contours are included in reports of this series only for those years or areas for which applicable data are available and are important to a discussion of changing groundwater conditions. The report includes individual discussions of selected major areas of groundwater development in the State for the period from the spring of 1988 to the spring of 1989. Much of the data used in the report were collected by the Geological Survey in cooperation with the Division of Water Rights, Utah Department of Natural Resources. (USGS)
W90-03543

BIANNUAL WATER-RESOURCES REVIEW, WHITE SANDS MISSILE RANGE, NEW MEXICO, 1986 AND 1987.
Geological Survey, Albuquerque, NM. Water Resources Div.
R. G. Myers, and S. C. Sharp.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-49, June 1988. 36p, 11 fig, 9 tab, 10 ref.

Descriptors: *Water resources data, *Groundwater data, *Hydrologic data, *White Sands Missile Range, *New Mexico, Groundwater, Water quality.

Hydrologic data were collected at White Sands Missile Range, New Mexico in 1986 and 1987. The total groundwater withdrawal in 1986 was 565,462,500 gal and in 1987 it was 620,492,000 gal. The total groundwater withdrawal was 110,971,300 gal less in 1986 than in 1985, but

55,029,500 gal more in 1987 than in 1986. Water samples from five Post Headquarters water supply wells were collected for chemical analysis in 1986. In 1987, water samples were collected from four test wells in the Post Headquarters area for analysis of selected volatile organic compounds. Twenty-eight water samples from wells were collected for analysis of specific conductance in 1986 and 1987. (USGS)
W90-03544

SIMULATED WATER-LEVEL AND WATER-QUALITY CHANGES IN THE BOLSON-FILL AQUIFER, POST HEADQUARTERS AREA, WHITE SANDS MISSILE RANGE, NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-03545

8. ENGINEERING WORKS

8A. Structures

OVERALL VIEW OF THE PROBLEMS CONCERNING THE HYDRAULIC ALERT CAUSED BY THE NATURAL DAM AND THE LAKE FORMED AFTER THE LANDSLIDE OF VAL POLA (UNE VUE D'ENSEMBLE DES PROBLEMES CONCERNANT L'ALERT HYDRAULIC CAUSEE PAR LE BARRAGE NATUREL ET PAR LE LAC QUI S'EST FORME PAR SUITE DE L'EBOULEMENT DE VAL POLA).
Ente Nazionale per l'Energia Elettrica, Milan (Italy). Centro di Ricerca Elettrica.
For primary bibliographic entry see Field 4A.
W90-02554

CONSTRUCTION OF IN SITU CONCRETE-ENCASED STEEL PENSTOCKS AT PUMPED-STORAGE STATIONS.
For primary bibliographic entry see Field 8F.
W90-02556

CALCULATION OF THE CAPACITY OF UNLINED CANALS AND CHANNELS.
O. M. Aivazyan.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 1, p 11-21, July 1989. 7 fig, 4 tab, 15 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, p 18-26, January 1989.

Descriptors: *Hydraulic design, *Canal design, *Canals, *Water-carrying capacity, Canal linings, Velocity, Irrigation canals, Navigation canals, Economic development, Chezy equation, Darcys law, Sand, Hydraulic radius, Flow discharge, USSR.

Interest in the hydraulics of large canals (ship, irrigation, or multi-purpose) has increased in connection with the needs of the developing economy. In calculations of the capacity and velocity regime of canals larger than existing and investigated ones, the most controversial problem is a determination of the Chezy coefficient (C). It is necessary to to evaluate the correspondence to the prototype of the formulas used to obtain C in order to select the most correct one and to determine the possibility of its extrapolation to uninvestigated regions. The relation of the Darcy coefficient was substantiated. The values of its parameters for canals in cohesive soils under average operating conditions and canals and rivers in a sand or sand-pebble bed are constant in the entire engineering range, which makes it possible to substantially increase the reliability of calculations of the capacity and velocity regime of canals of a given category. It follows from the analysis that the presently-used classification of canals according to the value of the hydraulic radius or discharge is artificial and unsuitable. (Fish-PTT)
W90-02558

Group 8A—Structures

GROUTING WORKS IN THE CONSTRUCTION OF THE SIDE GROUT CURTAINS OF THE AL-QADISIYAH HYDRO DEVELOPMENT (IRAQ).
For primary bibliographic entry see Field 8F.
W90-02563

ECONOMICS OF DAM FAILURE: ANOTHER LOOK AT CATASTROPHIC LOSSES.
Colorado State Univ., Fort Collins. Dept. of Economics.
For primary bibliographic entry see Field 6C.
W90-02582

USE OF ASPHALT MATERIALS IN JOINING EARTH DAMS.
For primary bibliographic entry see Field 8F.
W90-02699

PROPER SECTION OF THE SUPPLY SYSTEM OF LOCKS.
G. F. Onipchenko.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 2, p 104-109, August 1989. 9 fig, 12 ref.

Descriptors: *Hydraulic engineering, *Locks, *Water supply, Water resources, Available water.

When designing navigation locks the selection of the supply system is regulated by the building codes generalizing the experience of their investigations and operation up to the time the standards were published. The brevity of the standard regulations does not make it possible to present their detailed substantiation and the interrelation of the main parameters and their effect on selecting the design of the supply system within the scope of the recommended type. A few recommendations could make selection easier. For locks with a head not exceeding 1.5 of the initial depth in the chamber it is most expedient to use the simplest supply systems of the lock-head type with filling from under the gate. For heads exceeding the initial depth in the chamber by more than 1.5 times, prevention of the entrainment of air by the flow filling the chamber should be provided. An analysis of the laboratory and onsite data shows that the complication of the culvert supply systems from a certain level is not paid back by an acceleration of ship passage and improvement of ship mooring. Thus, for locks with a head on the chamber up to 40 m, it is recommended to use a scheme with not more than four outlet sections. An additional supply system can be used for accelerating the filling of high-head locks. The regime of the combined operation of main and additional supply systems is selected by model investigations. (Mertz-PTT)
W90-02700

REFINED MODEL OF THE EFFECT OF A RESERVOIR ON ROCK FOUNDATIONS OF HIGH DAMS.
V. V. Tetelmin, and V. A. Ulyashinskii.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 2, p 115-119, August 1989. 2 fig, 1 tab, 9 ref.

Descriptors: *Model studies, *Concrete dams, *Hydraulic engineering, Reservoirs, Seepage control.

Calculations of the force effect of a reservoir and seepage flow on concrete dams and their rock foundations is carried out in conformity with the building codes SNiP II-16-76 and SNiP II-54-77. The calculated settlements of dam foundations, as the results of onsite observations show, is 1.5 to 2 times less than those actually observed. Several factors need to be reassessed. Force factors caused by the seepage flow in the mass of the fractured foundations and seepage processes in rock foundations of high-head hydro developments from an elastic regime of seepage were considered. Refinement of the calculated dimensions of the active region of the rock foundation and correction of the method of extending the bulk seepage forces to the surface of the reservoir bed were also redone. Finally, deep cooling action of the seepage flow on the rock mass and gradual decrease of the modulus of deformation of the rock foundation were added

into the calculations. Consideration of the entire set of effects on the foundation of the reservoir made it possible to design an effectively working subsurface contour of dams that ensure reliable operation of the structure. (Mertz-PTT)
W90-02702

CALCULATION OF THE STRENGTH AND DESIGN OF WELDING LOOPS AND LINEAR ANCHOR JOINTS IN COMBINED PRECAST-IN SITU REINFORCED CONCRETE MEMBERS.
A. S. Zalesov, A. P. Kirillov, O. D. Rubin, and S. V. Sleznev.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 2, p 120-124, August 1989. 2 fig, 10 ref.

Descriptors: *Dam construction, *Dams, *Construction joints, *Regulations, Weldless joints.

This study investigated weldless joints in combined precast-in situ reinforced panels. In weldless loop joints, it is recommended that the diameter of bending of the loop be not less than 8 times the diameter of the concrete core. In the concrete core longitudinal bars, the diameter should be not less than 0.5 times the core diameter. There should be at least four of these bars present. For a joint absorbing the bending moment the length of the rectangular section should be not less than 5 times the core diameter. Weldless linear anchor joints should be not less than 20 times the core diameter, while linear anchor joints located in the compressed zone of the bending element should be not less than 15 times the core diameter. Transverse bars should be installed on the ends of the main steel of the ribs and overlapping steel. There should be at least two bars on each end of the main steel of the ribs. The assembly tie rods uniting the reinforced panels into a three-dimensional block should be located at a distance from the axis of the joint not exceeding 150 mm. The method developed from unified positions is suitable for calculating the strength of weldless joints. This simplified method of calculating joints presented in this paper and the recommendations on design make it possible to carry out design studies in a simple engineering form. (Mertz-PTT)
W90-02703

SAFER DAMS.
O'Brien and Gere Engineers, Inc., Blue Bell, PA.
R. Bowers.
Civil Engineering, Vol. 59, No. 9, p 61-64, September 1989. 3 fig.

Descriptors: *Safety, *Earth dams, *Dam stability, *Dam inspection, Embankments, Spillways.

The Army Corps of Engineers administered a program to inspect more than 8000 (mostly earth) dams classified as 'high hazard', meaning they are located near populated areas. The vast majority of them needed repairs of earth embankment problems and/or spillway outlet problems. Seepage problems usually developed as a result of inadequate design considerations or improper construction procedures; rehabilitation generally focuses on seepage control, rather than seepage prevention. Slope stability problems were most common in dams designed prior to development of modern analysis techniques; unstable earth dams can be rehabilitated by constructing flatter slopes, stabilization berms, or drainage systems. Vegetation overgrowth often occurred on dams that were not properly maintained, particularly in cases where seepage developed along the downstream face of the embankment; rehabilitation for such dams includes clearing, grubbing, and establishing low-maintenance ground cover. Many dams had inadequate spillway capacities; remediation methods include improving discharge efficiencies, increasing crest lengths, adding auxiliary sections, and raising the top of the dam. Structural-stability analyses indicated that gravity spillway sections for many earth dams did not meet current criteria; two popular methods of spillway stabilization are buttressing the downstream face with mass concrete and post-tensioned anchoring of the section to the bedrock foundation. Many of the drawdown portions of low-level outlet facilities were inoperable

or hydraulically inadequate; repair or replacement of the gates and operating mechanisms is a common step in dam rehabilitation. (Cutty-PTT)
W90-02735

MODEL STUDY OF PRADO FLOOD-CONTROL DAM: HYDRAULIC MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W90-02923

NETWORK MODEL ASSESSMENT TO LEAKAGE OF FILL DAM.
Gifu Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-03089

STUDY ON THE FORMATION OF TRIASSIC 'GYPSUM-DISSOLVED-STRATA' IN GUIZHOU PROVINCE AND THE SEEPAGE PREVENTION FOR RESERVOIRS.
Water Conservancy and Hydropower Survey and Design Inst. of Guizhou Province, Guiyang (China).
For primary bibliographic entry see Field 8E.
W90-03176

CHARACTERISTICS OF KARST HYDROGEOLOGY AND LEAKAGE OF NIUKOUYU RESERVOIR IN BEIJING.
Institute of Geography, Kunming (China).
For primary bibliographic entry see Field 2F.
W90-03178

CAN WATER LOSSES FROM RESERVOIRS IN KARST BE PREDICTED.
Karlova Univ., Prague (Czechoslovakia). Dept. of Hydrogeology and Engineering Geology.
For primary bibliographic entry see Field 2F.
W90-03179

FLOW-INDUCED VIBRATIONS OF RECTANGULAR CYLINDERS.
Lahmeyer International G.m.b.H., Frankfurt am Main (Germany, F.R.).
For primary bibliographic entry see Field 8B.
W90-03219

BASIC PRINCIPLES OF THE ORGANIZATION OF SYSTEMS PROVIDING RELIABILITY AND QUALITY CONTROL OF THE CONSTRUCTION OF HIGH EARTH DAMS.
A. G. Ghernikov.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 9, p 515-519, March 1989. 2 ref.

Descriptors: *Earth dams, *Dam construction, *Dam stability, *Quality control, *Project planning, Design criteria, Soil tests, Construction methods, Control systems, Data processing.

An important part of any earth dam project is a system of providing reliability of the dam at all stages of design and construction. The general scheme of such a quality control program should consist of three main subprograms: design assurance subprogram, quality evaluation subprogram, and quality control subprogram. In addition to the three main subprograms, an auxiliary subprogram of onsite observations during construction, verification of the reliability of the results of surveys during construction, and investigation of the service characteristics of the earth materials should exist. It is important to determine the standard values and assign the calculated and control values of the soil parameters. The quality evaluation subprogram is realized during construction of the earth dam. This part of the quality program may include automated control systems. Finally a procedure should be determined for accumulating and processing information about the quality of constructing a dam and its behavior on the basis of the

data of geotechnical control, construction supervision, and onsite observations. (Geiger-PTT)
W90-03247

ONSITE MEASUREMENTS AND MONITORING OF THE STABILITY OF EARTH DAMS.
N. A. Krasil'nikov.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 9, p 520-523, March 1989. 3 fig, 2 tab, 6 ref.

Descriptors: *Earth dams, *Dam construction, *Dam stability, On-site tests, Standards, Dam foundations, Monitoring.

The problem of establishing the maximum allowable indices (MAI) of monitoring and measuring (MM) instruments for providing routine monitoring of the state of earth dams is examined and recommendations on determining these indices and interpreting data of onsite measures by MM instruments on earth dams are given. When determining the values of the MAI of the MM instruments it is necessary to consider slope stability, clay properties, timely placement and reading of MM instruments during construction, calculation of a graph and/or nomogram for each observed cross section of the dam, and correspondence of the allowable values of the indices of the MM instruments with the values of the stability factors adopted for construction and operating periods. The application of these principles to the construction of the right-bank earth dam of the Kureika hydroelectric station is illustrated. (Geiger-PTT)
W90-03248

NEW INSTRUMENTS FOR ROUTINE MONITORING OF STRUCTURES AT THE SAYANO-SHUSHENSKOE HYDROELECTRIC STATION.
For primary bibliographic entry see Field 7B.
W90-03249

EXPANSION JOINT FOR LARGE-DIAMETER REINFORCED-CONCRETE WATER CONDUITS.
V. N. Zaitsev, O. V. Mikhailov, S. A. Berezinskii, V. V. Lgalov, and O. B. Lyapin.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 9, p 527-529, March 1989. 1 fig, 5 ref.

Descriptors: *Expansion, *Construction joints, *Hydraulic structures, *Concrete construction, *Reinforced concrete, *Conduits, Performance evaluation, Sealants, Plastics, Load testing, Inspection, Construction materials, Rubber.

A new design for a flexible butt joint for conduits was proposed. The proposed design retains its performance under such factors as a difference in the diameters of the pipeline sections being joined, their displacement in the vertical (difference of settlements) and horizontal (lateral shifts) planes, or changes of axes. Variations of this butt joint for large-diameter reinforced-concrete pipelines feature a cover plate with a double-curvature form (a shell of negative Gaussian curvature). To protect the soft elements of the butt joint from damage, polyethylene cover plates and sealing element (rubber) are provided for on top of the plate. The expansion joint was tested by a mechanical system, fragment of the pipeline, and loading method. The inspection of the joint showed a satisfactory state of all elements of the butt joint. The second stage of testing the expansion joint was its pressure loading after rotating the plane of joining the sections to one another. Rotation of the section caused displacement of two diametrically opposite points of the expansion joint by 10 mm each vertically and simultaneously by 6-7 mm horizontally, forming ledges. After 20 loading cycles at a pressure p = 1.6 + or -0.2 MPa, all the elements were found to be in a satisfactory state. (Geiger-PTT)
W90-03250

ECOLOGICAL ASPECTS OF THE OPERATION OF THE KIEV HYDROELECTRIC STATION IN A PUMPED-STORAGE REGIME.
For primary bibliographic entry see Field 6G.
W90-03254

EVALUATION OF THE STRENGTH OF CONCRETE WITH CONSIDERATION OF ITS WORKING CONDITIONS IN A MASSIVE HYDRAULIC STRUCTURE.
For primary bibliographic entry see Field 8F.
W90-03256

BREAKTHROUGH OF WATER INTO THE TEMPORARY DIVERSION TUNNEL OF THE SPANDARYAN RESERVOIR ON THE VOROTAN RIVER.
N. A. Lopatin.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 9, p 558-561, March 1989. 1 fig.

Descriptors: *Tunnels, *Reservoirs, *Structural engineering, *Hydroelectric plants, *Seepage, *Accidents, *Tunnel failure, *Diversion structures, Geologic fractures, Flow discharge, Tunnel linings, Erosion, Drawdown, Outlets, Runoff, Water hammer, Grouting, Low flow, Pumping plants, Cofferdams.

The reservoir of the Spandaryan hydroelectric station, which began to be intensely filled on May 9, 1988, was accidentally discharged through the temporary diversion tunnel when the water flowed into it with the gate closed through a geological fracture at a distance of 40 m from the water intake. The seepage discharge at the outlet of the tunnel was 20-25 liters/sec. The lining of the walls and crown of the tunnel over the entire length was preserved and there were no visible damage and deformation. The invert at the end part was damaged, and gulleys amounted to 20-80 cm. By the end of May 31, the discharge at the tunnel outlet increased to 140-160 cu m/sec. Complete drawdown of the reservoir occurred on June 8, 1988. Construction of a plug for the tunnel coincided with the high-water period of river runoff. As a result of rapid filling of the upper stretch of the tunnel after plugging, a strong water hammer occurred in the region of the plug, which led to destruction of the tunnel lining and the freshly placed plug. Strengthening of the concrete support in the tunnel and subsequent grouting was recommended. All works must be performed in the low-flow period. Water will be pumped from the low-water discharge of the river into the lower pool of the dam to empty the diversion tunnel. A temporary cofferdam will be constructed near the portal of the diversion tunnel for storage of the river runoff and its pumping by the pump station. (Geiger-PTT)
W90-03257

USE OF INFLATABLE WEIRS FOR WATER LEVEL REGULATION.
Floecksmuhle Energietechnik G.m.b.H., Aachen (Germany, F.R.).
U. Dumont.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 10, p 44-46, Oct 1989. 3 fig.

Descriptors: *Weirs, *Hydraulic structures, Inflatable weirs, *Regulated flow, *Weirs, West Germany, Construction methods, Fish guiding, Environmental protection, Costs, Maintenance.

Inflatable weirs are relatively new in Europe, but have proved successful in service in North America and Japan. They have many applications and are particularly suitable for low head of water; they can have almost unlimited width. The new weir consists of a concrete structure placed in front of the old weir in which the assembly rails and the regulating pipework are installed. To seal the structure against the sub-base, sheet piling was first driven, and this served to retain the water at the same time. At the Uhingen, West Germany weir the ecological requirements concentrated on three points: a newly developed fish pass; automatic discharge of an ecologically desirable flow; and record-keeping of the headwater level and the inflatable tube height. Inflatable weirs offer an alternative to more conventional methods of weir construction, with the inherent advantage of low initial cost, simple operation, and minimal maintenance. (Mertz-PTT)
W90-03310

COST-EFFECTIVE SELECTION OF CULVERTS FOR SMALL FOREST STREAMS.
New Zealand Forest Service, Rotorua. Forest Research Inst.
G. Murphy, and M. R. Pyles.
Journal of Forestry JFUSAI, Vol. 87, No. 10, p 45-50, Oct 1989. 4 fig, 2 tab, 10 ref.

Descriptors: *Streamflow forecasting, *Design flow, *Forest management, *Hydraulic structures, *Cost analysis, *Culverts, *Economic aspects, Costs, Hydrologic aspects, Hydraulic properties, Environmental impact, Maintenance costs, Failure costs, Economic life, Decision making.

A recently-described approach to culvert selection incorporates a hydrologic probability function and hydraulic and environmental considerations. An economic analysis of highway culverts based on expected annual costs, including original installation, maintenance, and cost of damage resulting from failure has also been proposed. These hydrologic probability functions and cost components can be used to arrive at the total discounted cost of each culvert alternative. The advantage of total discounted cost is that predictable aperiodic costs can be easily included even if they cannot be reasonably annualized. Minimizing the total discounted cost of the culvert installation is a simple and meaningful way of arriving at a cost-effective design. Total discounted cost is the sum of the original installation cost, the discounted annual maintenance costs, and the discounted expected costs of culvert failures that could be caused by peak flows. Maintenance and expected failure costs should be discounted over the design life of the installation. Practicing foresters and forest engineers can make better management decisions by using this procedure to identify the least-cost culvert for original construction on new roads, or replacement of culverts at the end of their service life or following a failure. (Mertz-PTT)
W90-03316

KARAKAYA DAM AND POWERPLANT.
9 Eylul Univ., Izmir (Turkey).
U. Ozis, and I. Ozel.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 7, p 20-24, Jul 1989. 6 fig, 16 ref.

Descriptors: *Arch dams, *Gravity dams, *Reservoirs, *Hydroelectric power, Dam design, Hydraulic turbines, Concrete dams, Water resources development, Rural areas, Developing countries, Hydraulic design, Regional planning.

The completed 173 m-high 1800 MW Karakaya arch gravity dam has an average energy generation of 7.5 TWh/year. The drainage area of the Euphrates at the Karakaya dam site is 80,538 square km. The mean flow is estimated to be 700 cubic m/s. The Karakaya reservoir extends 166 km upstream in narrow gorges to the foot of the Keban scheme. It covers an area of 298 square km at maximum water level, and has a gross storage volume of 9.6 billion cubic meters. Karakaya benefits greatly from the regulatory effect of the Keban reservoir upstream, which controls more than four-fifths of its inflow. The diversion of the Euphrates river during construction of the dam was accomplished by upstream and downstream cofferdams and two tunnels through the right bank with a capacity of 3500 cubic m/s. The inner diversion tunnel has now become a bottom outlet designed to release up to 800 cubic m/s of water. An overflow spillway of 17 thousand cubic m/s capacity on the crest of the dam is equipped with 10 tainter gates. The dam was concreted in three short and 24 equal-size blocks having widths of 18 m upstream and 14 m downstream, and lengths of 50 m at the base and 10 m at the crest. The dam is equipped with five inverse pendula and five inclinometers and a total of 154 jointmeters, 27 thermometers, five pairs of strainmeters, 12 manometers, three uplift pressure meters and 12 sets of deformation meters. There are six intakes in the dam body, each serving a separate penstock; each is provided with a trashrack measuring 18 m by 18 m. Six 133 m-long penstocks supply the turbines. The powerhouse is at the toe of the dam, under the

spillway chute in the narrow gorge and is accessible through a 380-m long tunnel. The switchyard is 2.5 m to the southeast of the dam site and covers an area of 75,000 square meters. (Ence-PTT)
W90-03324

INFLUENCE OF RESERVOIR LOADING ON DAM STRESSES AND DEFORMATIONS.
M. A. M. Herzog.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 7, p 26-28, July 1989. 4 fig, 2 tab, 12 ref.

Descriptors: *Dams, *Dam design, *Reservoirs, *Stress analysis, Deformation, Deflection, Rockfill dams, Gravity dams, Arch dams, Case studies, Dam construction.

Measured dam deformations have often been found to be smaller than anticipated on the basis of theoretical calculations. One reason for this is the settlement of the valley floor and flanks when subjected to the load of the impounded water. How dams of any type are influenced by deformation of the reservoir caused by the water load is demonstrated using case studies. The Gepatsch dam is a 153 m-high rockfill dam in the Tyrolean Alps constructed between 1961 and 1964. The total of calculated deflections and settlements was found to be 34 mm. After 13 years of operation, the measured crest deflections were between 30 and 40 mm per cycle of reservoir drawdown and filling. The deceleration of crest deflections from 180 mm in 1964 results from an increasing value of Young's modulus for the shell material because of consolidation, aided by the breaking of rockfill corners and edges. The Grande Dixence dam is a 285 m-high straight gravity dam with grouted construction joints in the Valaisan Alps built between 1951 and 1962. The total calculated deflection was 91 mm. The measured crest deflection per cycle was approximately 85 mm between 1971 and 1975 and 78 mm between 1976 and 1980. The difference between the calculated and measured crest deflections is due to the disregard of three-dimensional action of this straight gravity dam in a narrow valley. The Kolnbrein dam is a 200 m-high constant angle arch dam in the Carinthian Alps. The deflection calculated for October 1983, at an elevation of 1092 m, was 103 mm; the corresponding measured deflection was 98 mm. The deflection calculated for April 1983, at an elevation of 1720 m, was 6 mm; the measured deflection was -20 mm (an upstream deflection). In this case, the tensile stresses induced by valley widening and floor rotation were large enough to cause problems when they were not taken into consideration in the design. These three case studies demonstrate that the deformations of the foundation rock at the valley floor and flanks should not be considered to be negligible when calculating the deformation and stresses in a dam. (Ence-PTT)
W90-03325

ANALYSIS OF AN EXPERIMENTAL ARCH DAM FAILURE.
R. Naihua.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 7, p 30-33, July 1989. 2 fig, 2 tab.

Descriptors: *Arch dams, *Dam failure, *China, *Dam design, Theoretical analysis, Structural engineering.

The construction, failure and analysis of the failure mode of an experimental arch dam in China has been analyzed. The structure was built in 1981 at a coastline site, at the mouth of a small river. The construction of the dam was completed in May 1981, and failure took place in September of the same year. The failure caused no loss of life or damage to property. The dam was a masonry structure composed of a cylindrical arch with a fixed center and a constant radius with a central angle that varied between 92 and 32 degrees from top to bottom and a peripheral joint set at a maximum depth below the crest of 15.7 m, ending 1.7 m below the crest at each abutment. The dam failure occurred by an upward movement along the peripheral joint as a result of the insufficient mass of

the dam body and/or the shallow inclination of the peripheral joint at the valley sides. It was concluded that the slope of the valley banks of an arch dam site should not be more gentle than 45 degrees. If this is unavoidable, the structure should not be provided with a peripheral joint without a thorough investigation of the foundation. The steeper the valley sides, the thinner the dam body can be. At the preliminary design stage, the equation for stability against upward sliding is recommended as a safety check. It is also suggested that existing structures with slope angles less than 45 degrees should be examined, and this stability equation applied as part of the investigation. (Ence-PTT)
W90-03326

STEPPED PROTECTION BLOCKS FOR DAM SPILLWAYS.
Moscow Inst. of Civil Engineering (USSR).
Y. P. Pravdivets, and M. E. Bramley.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 7, p 49-56, July 1989. 7 fig, 8 ref.

Descriptors: *Spillways, *Overflow channels, *Dam design, *Dam construction, Hydrodynamics, Economic aspects, Stepped protection blocks.

In the USSR, dam engineers are considering various methods of protecting open-channel spillways on erodible foundations to achieve a high discharge capacity with a high degree of safety. The stepped block system is somewhat unique in that it exploits fluid dynamics principles to achieve stability. It can also be readily adapted for use in diversion works during dam construction and for providing additional spillway capacity to existing dams because of the ease of construction and the low cost per installed unit discharge capacity. Using this design, the cost of both temporary and permanent overflow works on a hydropower scheme with an earth dam can be reduced. Design of stepped block protection must consider the overall spillway and its foundations as well as the component elements, namely the spillway cross-section, the crest and the tailwater transition. Stepped blocks will perform satisfactorily on granular embankments of medium permeability as well as low permeability earthfill. The drainage openings in stepped blocks not only prevent a build-up of hydraulic pressure in the underlayer during spillway operation but also afterwards when the subsoil/underlayer drains. The preferred spillway cross-section for economy and ease of construction is trapezoidal, with stepped blocks laid on the sloping sides. The underlayer construction may either comprise several layers of granular material or may incorporate one or more geotextiles. The spillway toe and tailwater transition must dissipate the specific energy of the flow without adversely affecting the stability of the blocks or causing excessive scour downstream. The spillway slope should be no steeper than about 1:6 over a length of 6 to 8 flow depths upstream of the tailwater. The spillway design can only be partly standardized; every spillway requires competent engineering design input which addresses the specific problems of the particular site. (Ence-PTT)
W90-03328

RIPRAP DESIGN.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W90-03334

LIMITATIONS OF DE SAINT VENANT EQUATIONS IN DAM-BREAK ANALYSIS.
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03335

SPILLWAY DISCHARGE CALCULATIONS IN NWS DAMBRK.
Army Engineer Div. North Pacific, Portland, OR.
For primary bibliographic entry see Field 8B.

W90-03337

HYDRAULIC JUMP TYPE STILLING BASIN FOR LOW FROUDE NUMBERS.
Regional Engineering Coll., Kurukshetra (India).
For primary bibliographic entry see Field 8B.
W90-03339

GEOTECHNICAL MONITORING PROGRAMMES FOR EMBANKMENT DAMS.
For primary bibliographic entry see Field 8D.
W90-03386

SOFTWARE FOR INTEGRATED DAM MONITORING SYSTEMS.
Coyne et Bellier, Paris (France). Dams and Hydraulics Dept.
For primary bibliographic entry see Field 8G.
W90-03387

DESIGN OF PLATANOVRYSSI: EUROPE'S HIGHEST RCC DAM.
Public Power Corp., Athens (Greece).
E. Kolonias, M. R. H. Dunstan, J. L. Hinks, and A. F. Copley.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 11, p 22-27, November 1989. 11 fig, 2 tab, 11 ref.

Descriptors: *Concrete dams, *Dam design, *Dam construction, *Stress analysis, *Seismic properties, Platanovryssi Dam, Greece.

The 95 m-high Platanovryssi dam in northern Greece, on which construction is expected to start next year, will be the largest roller-compacted concrete (RCC) dam so far constructed in Europe. The Platanovryssi reservoir will be the second in a cascade of three planned for the Nestos river by the Public Power Corporation of Greece. A comprehensive series of trial mixes was carried out during the design phase because it was intended to use a high-lime flyash, emanating from the Ptolemaida thermal power station owned by the Public Power Corporation, and this particular flyash did not conform to any standard specification, nor had it been used as a separate ingredient in concrete to any great extent. Alongside investigation of the RCC mix, an extensive study was made to predict the thermal and stress histories for the dam both during construction and during the 20-year cooling period after construction. An analysis was also made of stresses within the dam under seismic loading. (Author's abstract)
W90-03388

ROLLER COMPACTED CONCRETE ARCHED DAMS.
Department of Water Affairs, Pretoria (South Africa).
For primary bibliographic entry see Field 8F.
W90-03389

AKIHA EXTENSION IN JAPAN.
Electric Power Development Co. Ltd., Tokyo (Japan).
K. Watanabe.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 11, p 43-47, November 1989. 6 fig.

Descriptors: *Hydroelectric plants, *Dam design, *Dam construction, *Excavation, Akiha Dam, Japan.

The Tenryu river in Japan has a high flow rate, which makes it necessary to release considerable quantities of water through the spillway of Akiha dam. It is planned that Akiha No. 3 power station will utilize this water to produce additional power. The intake and part of the penstock for Akiha No. 3 have been designed to be installed through excavation of the existing dam body. This design was made possible by straightforward dewatering of the intake work area and recently developed non-blasting excavation techniques. The forebay for the

intake of the Akiha No. 1 station is upstream of the new intake. By closing this forebay and draining the water, the upstream face of the dam could be made dry without lowering the reservoir. In addition, it was possible to apply the company-owned tunnel boring machine to the excavation of the new tailrace tunnel. These factors reduced the project cost and contributed to realizing the construction plan. After its completion, No. 3 will be the main power station of the overall Akiha scheme and the number of days annually of releasing water through the spillway will be reduced from 100 to 40. (Sand-PTT)
W90-03391

MODELING OF UNSTEADY FLOW IN CURVED CHANNEL.
Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 8B.
W90-03396

PIPE JOINT RESTRAINTS.
S E A Consultants, Inc., Cambridge, MA.
T. M. Stinson.
Journal of the New England Water Works Association JNEWA6, Vol. 103, No. 3, p 129-143, November 1989. 6 fig, 8 ref.

Descriptors: *Pipes, *Pipelines, *Construction joints, Thrust blocks, Gravity blocks, Tie-rods, Restraining fittings, Concretes.

There are several methods to restrain pipe joints from movement, including concrete reaction blocks, restraining fittings, and tie-rods. Thrust blocks are the most common method of restraining joints. Properly installed, they provide an adequate method of eliminating joint movement due to thrust in both lateral and vertical direction. Thrust blocks have the advantage of being inexpensive, are relatively easy to construct, and are corrosion resistant. Gravity thrust blocks are also used when a bend is in the vertical direction and the block is designed so that the weight of the block offsets the thrust force in the vertical direction. Thrust and gravity block are limited in use under the following conditions: (1) poor soils, such as muck or swamp areas; (2) lack of space, common in urban areas; (3) areas of future excavation, where pipeline failure could result; and (4) size of the block prohibits its placement. Restrained joints are used when concrete blocks are not economical or feasible. A restrained joint system is based on pipe diameter, pressure, depth of cover and soil characteristics. In this type of system the thrust forces must be restrained by the pipe reaction with the surrounding soil. Because of this reaction, compaction of the trench backfill is extremely important. Restrained joints offer an advantage over concrete blocks as it allows the engineer to design for future conditions which could effect the pipeline integrity. If the main is to be installed in an area in which settlement can occur due to poor subsoil conditions, the use of restrained joints can help reduce the risk of joint separation. In addition to buried water mains, thrust restraints are also required in pumping stations, treatment plants and similar facilities. Normally, interior piping is flanged, providing a completely restrained system. However, when couplings interrupt the continuity of the flanged system, a suitable device must be installed to maintain pipeline integrity. The most common device is the tie-rod. Tie-rods are also used on exterior pipelines and the interior valve leaving the station. With proper design and installation, pipe joint restraints should provide necessary safeguards against pipe joint failures which can lead to excessive damage to surrounding areas or an undetectable leakage of water from mains. (Sand-PTT)
W90-03402

8B. Hydraulics

TIME DEPENDENT TRANSPORT PROBLEMS BY BEM.
Maribor Univ. (Yugoslavia). Dept. of Mechanical Engineering.
P. Škerget, G. Kuhn, A. Alujevic, and C. A.
Brebbia.
Advances in Water Resources AWREDI, Vol. 12, No.1, p 9-20, March 1989. 8 fig, 3 tab, 27 ref.

Descriptors: *Hydraulics, *Mathematical analysis, *Boundary conditions, *Fluid mechanics, *Fluid flow, *Plane flow, Laminar flow, Energy transfer, Cavitation, Numerical analysis, Buoyancy, Vortices, Velocity, Kinematic viscosity, Kinetics, Mathematical equations, Convection, Finite element method, Finite difference methods.

Boundary element method (BEM) is applied to the numerical simulation of plane fluid flow and the energy transport problem (thermally driven cavity flows). The Boussinesq approximation is used to consider the buoyancy effects. The vorticity-velocity formulation is used to solve the fluid motion problem. Introducing the vorticity variable, the computation of the problem is partitioned on its kinematics and kinetics parts. The behavior and physical meanings of the different terms in the integral equations are discussed. Due to the fundamental solution, a part of the transport mechanism is transferred to the boundary producing a very stable numerical scheme. In general, the boundary integral equations behave well when the source point coincides with the boundary nodal points. The problem can arise with the integral equations involving the tangential derivatives of the fundamental solution when in some cases the source point does not coincide with the boundary nodes. The classical example of natural convection in closed cavity was studied and the numerical results obtained by BEM compared with those obtained by the finite difference and finite elements methods, and showed good agreement. To improve BEM solutions it is desirable to implement higher order elements; the corner effects' have to be considered with special care. (Fish-PTT)
W90-02546

BOUNDARY ELEMENT METHOD FOR 2D PROBLEMS OF IDEAL FLUID FLOWS WITH FREE BOUNDARIES.
Higher Inst. of Mechanical and Electrical Engineering, Sofia (Bulgaria).
V. Pasheva, and R. Lazarov.
Advances in Water Resources AWREDI, Vol. 12, No.1, p 37-45, March 1989. 14 fig, 16 ref.

Descriptors: *Boundary processes, *Fluid flow, *Flow around objects, *Boundary conditions, Direct flow, Synthesis, Design standards, Channels, Jets, Cavitation, Mathematical models, Numerical analysis, Model testing.

The application of a boundary element method is very useful in the case of solving boundary value problems in multiconnected, unbounded domains with curvilinear boundaries. Especially useful is the possibility of solving both direct and inverse problems, the inverse problems being particularly suited for synthesis in design. An application was developed using an indirect BEM for solving various problems of ideal fluid flows, such as flow around a wing or cascade of wings, flow around wings in a channel, jets, flows with developed cavitation and design of turbomachines based on these investigations. A mathematical exposition of these problems is given and the main features of the developed numerical technique are illustrated using two direct and two inverse boundary value problems. Numerical results of model and real problems are presented. (Fish-PTT)
W90-02549

ATTEMPT TO SYNTHESIZE KNOWLEDGE ON MOUNTAIN EROSION AND TORRENTIAL HYDRAULICS (ESSAI DE SYNTHESE DES CONNAISSANCES EN EROSION ET HYDRAULIQUE TORRENTIELLE).
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Saint-Martin d'Heres (France). Grenoble Group.
For primary bibliographic entry see Field 2J.
W90-02553

DETERMINATION OF THE PERMISSIBLE VELOCITIES IN CANALS.
E. I. Mikhnevich.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 1, p 5-11, July 1989. 1 fig, 1 tab, 13 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, p 14-18, January 1989.

Descriptors: *Canal construction, *Canal design, *Stable channels, *Erosion control, *Slope stability, Velocity, Soil physical properties, Flow friction, Porosity, Equilibrium, Soil mechanics, Velocity distribution, Sediment transport, Sediment erosion, Slope degradation, Slope protection, USSR.

The method of estimating the stability of canal channels on the basis of permissible velocities is widely used in the USSR. The existing formulas for permissible velocities have a number of common shortcomings. They do not take into account such important strength characteristics of soil as the coefficient of internal friction, porosity, etc. A model of equilibrium, in which an element of soil consisting of a number of particles in its upper layer is taken as the object of action, is more reliable. The values of the permissible velocities calculated by the proposed formulas were in satisfactory agreement with the experimental data. Consideration of the main physical and mechanical characteristics of soils in these formulas and the use of the power-law distribution of velocities reliably reflects the various stages of sediment movement. As a result of this evaluation, the model is recommended for evaluating the resistance of the bottom and slopes of canals to erosion. The resistance of slopes to erosion can be provided either by designating permissible noneroding velocities in the channel or by revetting them. The design of the revetments should be designated differentially over the height of the slope in conformity with the distribution of the permissible and vertical average velocities in the slope zone. (Fish-PTT)
W90-02557

WATER QUALITY MANAGEMENT IN CANALS AND PIPELINES.
F. V. Stolberg.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 2, p 80-83, August 1989. 3 fig, 1 tab, 6 ref.

Descriptors: *Water quality management, *Mathematical models, *Canals, *Pipelines, *Algal growth, Hydrological parameters, Velocity.

There are greater possibilities for water quality management in canals and pipelines, in comparison with rivers, since the abiotic part of their aquatic ecosystem in the form of structural and technological parameters can be assigned differently when designing and developing the operating regime. Anthropogenic eutrophication of natural waters, which leads to disturbance of the standard values of such indices as water composition and properties like the biomass of phytoplankton and dissolved oxygen content. Because a considerable part of water resources is supplied to consumers by a runoff distribution system, including water intakes, canals, and pipelines, it is possible to regulate the water quality by hydraulic engineering methods when withdrawing water from a eutrophic water source and transporting it to the consumer. Structure of canals depends on the morphometric characteristics of the channel, hydrological parameters, hydraulic structures, and in situ water protection works. A mathematical model is necessary for realization of such control. A limited set of initial data is needed for its use: morphometry of the water object, current velocity of the water, and initial conditions of the water quality. With these, it is easy to calculate entry into the stream of considerable masses of blue-green algae during the summer bloom and the extent of diatom blooms during spring and fall. Changing curves along the canal may change the incidence of algal blooms. Design of the water conduit to Donetsk (U.S.S.R.) to lessen algal blooms calls for alternating closed pipeline sections with a length of about 20 km each with open sections of the canals with a length of 1-2 km for aeration of water along the route. (Mertz-PTT)
W90-02694

Group 8B—Hydraulics

ENERGY AND HYDRODYNAMIC STUDIES OF TURBINE OPERATING REGIMES OF LARGE PUMPING STATIONS.
V. I. Vissarionov, V. V. Elistratov, and M. M. Mukhammadiev.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 2, p 84-87, August 1989. 4 fig, 5 ref.

Descriptors: *Pumping plants, *Turbines, *Hydroelectric plants, *Hydraulic engineering, Hydrodynamics.

To provide reliable operation of pumping stations, in addition to energy studies of the turbine regimes, it is necessary to determine the fluctuations of the hydrodynamic pressure on elements of the water passage. A series of energy and hydrodynamic studies to determine the operating characteristics of a horizontal bulb pump unit in stationary turbine regimes was performed. Studies were performed on a large-scale model device equipped with a pump having a diameter of 0.35 m, with a type OP-6 three-blade runner. Ranges of service typical of operating regimes were used. Operating characteristics were obtained for various angles of the runner blades and guide vanes. The possibility of operation of axial-flow pump units in a turbine regime was proved experimentally. To provide efficient operation of the pumping station in pump and turbine regimes, it was best to carry out double regulation by means of the runner blades and gate vanes. Maximum efficiency values were 81.5% in the turbine regime and 86% in the pump regime. For matching the operation of the unit in the optimal zones of both regimes it was recommended to use a static frequency changer. The blade frequency, frequency of revolution, and low-frequency oscillations excited by the vortex line behind the runner were the dominant frequencies of the pressure fluctuations process in turbine regimes with maximum energies. (Mertz-PTT)
W90-02695

DISTRIBUTION OF WATER DISCHARGES AND CURRENT VELOCITIES IN A BRAIDED CHANNEL.
For primary bibliographic entry see Field 2J.
W90-02696

FORMATION OF SAND RIDGES IN CANALS.
For primary bibliographic entry see Field 2J.
W90-02697

MAXIMUM CAPACITY OF CIRCULAR FREE-FLOW TUNNELS.
V. S. Borovkov, S. A. Pankratov, and N. L. Pankratova.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 2, p 96-98, August 1989. 2 fig, 4 ref.

Descriptors: *Closed-conduit flow, *Flow resistance, *Hydraulic engineering, *Tunnel construction, Mathematical models.

Refinement of the hydraulic calculation of the capacity of free-flow hydraulic tunnels is quite important in connection with their high cost and observed tendency toward constructing large tunnels. The need for maximum accuracy of the hydraulic calculation under these conditions is obvious. With use of the Altshul-Ludov formula, which was checked for large streams, an analysis was made of the maximum capacity of tunnels. This showed that the ratio of the maximum discharge characteristic to the discharge characteristic of a completely filled tunnel depends on the ratio of the hydraulic resistance coefficients for these cases. Filling corresponding to the maximum discharge characteristic is weakly dependent on the tunnel roughness and is close to 0.944 time the diameter and differs insignificantly from the filling 0.93 times the diameter regulated by building codes. (Mertz-PTT)
W90-02698

MODEL STUDY OF PRADO FLOOD-CONTROL DAM: HYDRAULIC MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station,

Vicksburg, MS. Hydraulics Lab.
J. F. George.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report HL-89-19, September 1989. Final Report. 43p, 2 fig, 13 photos, 15 plates.

Descriptors: *Hydraulic models, *Spillways, *Flood control, Prado Dam, Model studies, Flow profiles, Dikes, Weirs, Hydraulic profiles, Flow velocity, Flow discharge, Scour.

Tests were conducted on a 1:80-scale model of the Prado Dam on the Santa Ana River, near Los Angelos, CA, and spillway to determine the adequacy of proposed modifications to the existing structure to convey the revised design flow of 615,000 cu ft/sec (cfs). These modifications were to serve as an interim solution until decisions were made either to make major design modifications to the existing structure or construct a new structure upstream of Prado Dam that would control downstream flow releases. Unsymmetrical approach conditions to the spillway resulted in poor flow conditions at the left and right abutments at the weir, which caused a reduction in the effective length of the weir. Test results indicated that installing long approach walls on either side improved flow conditions at the weir, but did not significantly increase the capacity of the spillway or improve flow conditions on the spillway. Therefore, dikes were installed on the left and right abutments to streamline approach conditions to the spillway, thereby improving flow conditions at the weir. With design conditions the water surface exceeded proposed wall heights along the spillway. Additional wall height was obtained by paving a small berm and existing topography along each side of the spillway. A wall having a warped surface also had to be placed on top of the berm at the downstream end of the spillway chute to redirect any flow that overtopped the paved berm back onto the spillway. Flow conditions downstream of the flop bucket were unsatisfactory, with large standing waves present in the exit channel and a large eddy present between the spillway exit channel and the earth dam. Maximum velocities of 11 ft/sec were recorded along the toe of the dam with a discharge of 400,000 cfs. Due to the erodibility of the material in the exit channel, the potential is high for severe scour to occur in these areas with a major flood event. No noticeable backwater effects were observed from the constricted bridge crossing and highways just downstream of the spillway. The design discharge of 615,000 cfs simply submerges these structures. (Author's abstract)
W90-02923

TAYLOR WEAK STATEMENT CFD ALGORITHM FOR FREE SURFACE HYDROMECHANICAL FLOWS.
Tennessee Univ., Knoxville.
For primary bibliographic entry see Field 2E.
W90-03048

NUMERICAL SIMULATION OF THE VORTEX SHEDDING PROCESS PAST A CIRCULAR CYLINDER.
For primary bibliographic entry see Field 2E.
W90-03049

NUMERICAL INVESTIGATION OF TURBULENT FLOW FIELD IN A CURVED DUCT WITH AN ALTERNATING PRESSURE DIFFERENCE SCHEME.
Xian Jiaotong Univ. (China). Dept. of Power Mechanical Engineering.
Z. J. Liu, C. G. Gu, and Y. M. Miao.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 89-94, 6 fig, 1 tab, 6 ref.

Descriptors: *Mathematical studies, *Pipe flow, *Ducts, *Turbulent flow, Hydraulics, Navier-Stokes equations, Mathematical equations, Finite volume methods, Alternating pressure difference scheme, Algorithms, Prediction, Comparison studies, Pressure.

A finite volume method is presented for the solution of the two-dimensional, incompressible, steady Navier-Stokes equations with the K-epsilon turbulence model. A new scheme, alternating pressure difference scheme (APDS), is proposed to eliminate the pressure oscillation with an ordinary grid arrangement. This numerical method is applied to predicting the turbulent flow field in a curved duct, and the results are compared with the corresponding experimental data. The calculated mean velocity field agrees well with the experimental one, and the calculated turbulence intensity distributions have the same trend as the experimental ones. (See also W90-03036) (Author's abstract)
W90-03050

BOUNDARY ELEMENT INVESTIGATION OF NATURAL CONVECTION PROBLEMS.
Shinshu Univ., Matsumoto (Japan). Dept. of Mechanical Engineering.
M. Tanaka, K. Kitagawa, C. A. Brebbia, and L. C. Wrobel.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 103-114, 3 fig, 1 tab, 15 ref.

Descriptors: *Mathematical studies, *Convection, *Boundary element method, Navier-Stokes equations, Mathematical equations, Energy transfer, Numerical analysis, Computer programs.

A boundary element formulation is presented that employs a penalty function technique for steady natural convection problems. By regarding the convective and buoyancy force terms as pseudo-body forces, the standard boundary element analysis of elastostatics can be extended to solve the Navier-Stokes equations. In a similar manner, the standard boundary element analysis of potential problems can be applied to the energy transport equation. Emphasis is placed on accurate evaluation of the domain integrals resulting from the pseudo-source terms. A self-adaptive coordinate transformation technique proposed by Telles is used for this purpose. Numerical computation is carried out for some cases of a typical benchmark problem (two-dimensional natural convection in a square cavity, 164 boundary nodes, 289 internal nodes) to demonstrate the usefulness of the proposed solution procedure. Although the present work mainly concerns two-dimensional problems, it is straightforward to construct a computer program for three-dimensional problems. (See also W90-03036)(Rochester-PTT)
W90-03052

NEW FAMILY OF SHAPE FUNCTIONS.
Mississippi Univ., University. Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 7C.
W90-03053

ADAPTIVE COLLOCATION FOR BURGERS' EQUATION.
Wyoming Univ., Laramie.
M. B. Allen, and M. C. Curran.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 123-128, 1 fig, 9 ref. NSF Grants DMS-8504360 and RII-8610680.

Descriptors: *Mathematical studies, *Multiphase flow, *Advection, *Burgers equation, *Mathematical equations, Finite element method, Algorithms, Water resources engineering, Degrees of freedom, Computation.

An adaptive gridding algorithm for finite-element collocation improves resolution of steep fronts in advection-dominated flows such as Burgers' equation. The scheme decouples refinement equations from the overall linear system solved at each iteration of each time step. This decoupling preserves the matrix structure associated with coarse-grid calculations and facilitates parallel computation of the unknowns associated with refinement. The method was tested using the N-wave problem of

Cheng. The present local grid refinement scheme offers an efficient method for adding computational degrees of freedom to zones requiring fine-scale numerical resolution. The predictor-corrector iteration strategy gives rise to an algorithm that sidesteps the extra computations associated with refinement during the early Newton steps in each timestep of a nonlinear problem. The success of the method with Burgers' equation suggests that the approach will be useful in other nonlinear, advection-dominated flows in water resources engineering. (See also W90-03036) (Rochester-PTT)
W90-03054

RADIATIVE HEAT TRANSFER TO FLOW IN POROUS PIPE WITH CHEMICAL REACTION AND LINEAR AXIAL TEMPERATURE VARIATION.
International Centre for Theoretical Physics, Trieste (Italy).
A. R. Bestman.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 307-312, 1 tab, 4 ref.

Descriptors: *Mathematical studies, *Heat transfer, *Pipe flow, Temperature, Chemical reactions, Gas, Porosity, Mathematical models.

The flow in a cylindrical porous pipe is considered in the presence of chemical reaction and radiative heat transfer. If the temperature of the pipe varies linearly with axial distance, this extremely difficult three-dimensional problem can be tackled for low-Reynolds-number flows by asymptotic approximation and numerical integration. Formulation, perturbation and basic solution, and consequences of the effect of heat transfer at the wall are discussed quantitatively. The problem considered is the flow of a binary mixture of a dilute, chemically reacting gas, in a porous cylinder reclined at an angle to the horizontal. It is assumed that the Reynolds number is small. It was determined that increase in the radiation parameters or porosity parameter caused a decrease in the heat flux at the wall. (See also W90-03036) (Rochester-PTT)
W90-03080

NUMERICAL ANALYSIS OF TRANSIENTS IN COMPLEX HIDROPOWER SCHEME.
Eletrosul, Florianopolis (Brazil).
S. A. Furlani, and G. J. Correa.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 345-350, 4 fig, 3 ref.

Descriptors: *Brazil, *Hydroelectric plants, *Model studies, *Numerical analysis, *Hydraulic engineering, Tunnels, Penstocks, Design criteria, Load rejection, Hydrodynamics, Mathematical models, Forcacava Project, Simulation, Comparison studies, Hydraulic transients.

Penstock or power tunnel design requires a long-term engineering commitment, including selection of a convenient diameter and providing required turbine regulation stability during transient and permanent operation. A procedure is described that was used for the analysis of hydraulic transients during studies of the Forcacava Project, which will be part of the Fontes Hydrogenerating System in Rio de Janeiro State, Brazil. The project will include adding three 147-MW Francis turbines operating with 306 m head. Effects of load rejection by these three units on conditions in the tunnel leading to the powerhouse were simulated. The effects on other, existing turbines in the system also were determined. From the simulation a 6-m tunnel diameter was chosen and it was determined that the introduction of a surge chamber would not help correct transient conditions because it could not be placed in a convenient position. The model's capability to evaluate alternatives and the accuracy obtained (by running simulations on the existing Salto Santiago Power Plant and comparing the results with measured data) confirm the value of the model for analysis of hydraulic transients. (See also W90-03036) (Rochester-PTT)
W90-03086

NETWORK MODEL ASSESSMENT TO LEAKAGE OF FILL DAM.
Gifu Univ. (Japan). Dept. of Civil Engineering.
T. Sato, and T. Uno.
IN: Computational Methods in Water Resources, Vol.2: Numerical Methods for Transport and Hydrologic Processes. Elsevier, New York. 1988. p 363-368, 5 fig, 1 tab, 2 ref.

Descriptors: *Model studies, *Leakage, *Earth dams, *Groundwater movement, *Monte Carlo method, Stochastic models, Network model, Computer models, Performance evaluation, Pipe flow, Finite element method.

Groundwater flow analysis using the network model does not require a deterministic geological structure. All parameters in the model, such as the spatial coordinate of the node point, thickness, length, and permeability of the branch, are approximated by probabilistic variables. Monte Carlo simulation is used to obtain a solution. A case history of application of the network model for assessment of leakage through a fill dam and subsoils is given. Only widely scattered boring and in-situ test results were available for this site. The network model was constructed as simply as possible to save computation time. Three-dimensional finite element analysis also was performed to check the results. The quantity of leakage, estimated in three different situations, was similar for the finite element and the network model. However, the computation time on the M-360 computer was more than 10 times as long for the finite element procedure. The need for repetitions in finite element analysis when searching the phreatic surface and the fact that the network model approximates the groundwater flows as pipe flows account for the differences in computation times. Although the network model used here is practical, there are remains some problems to overcome, including optimization method, dealing with transient flows, and rules for determining numbers of zones, node points, and branches in the network. (See also W90-03036) (Rochester-PTT)
W90-03089

FLEXIBLE POLYHEDRON METHOD WITH MONOTONICITY ANALYSIS.
Zhejiang Univ., Hangzhou (China). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W90-03099

FLOW-INDUCED VIBRATIONS OF RECTANGULAR CYLINDERS.
Lahmeyer International G.m.b.H., Frankfurt am Main (Germany, F.R.).
S. J. Callander.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 10, p 1316-1331, Oct 1989. 7 fig, 27 ref, Append.

Descriptors: *Hydraulic structures, *Hydraulic engineering, *Flow characteristics, *Flow around objects, *Vibrations, Trash racks, Pipelines, Piles, Offshore platforms, Heat exchangers, Vortices, Coastal engineering, Underwater.

The problem of flow-induced vibrations in the direction of flow received prominence during the construction of the Immingham Oil Terminal in 1968 as long circular steel piles oscillated at unexpectedly low flow velocities. The aim of this research was to identify the various mechanisms causing flow-induced vibrations of rectangular cylinders. It is relevant to components of the following structures: trashracks; underwater cables and pipelines; jetties, piles and other coastal or river structures; offshore platforms; and tube bundles in heat exchangers. The flow-induced streamwise vibrations of rectangular cylinders with cross-sectional aspect ratios from 0.25 to 5 in a parallel approach flow of water were investigated. Experimental results are presented. The root-mean-square amplitude of the vibrations of cylinders whose cross sections are nearly square is very sensitive to small changes in reduced velocity, when the reduced velocity is near to the reciprocal of twice the Strouhal number. To study this behavior, records of the cylinder motion and photographs of

the wake were taken simultaneously, which allowed a correlation of the mode of vortex shedding with the vibration amplitude. The vortex shedding changes continuously, but not periodically, from alternate to symmetric and vice versa. Correspondingly, the vibration amplitude varies markedly, being small when the vortex shedding is alternate and large when it is symmetric. Vortex shedding and the cylinder motion interact with each other to excite and amplify the streamwise oscillations. (Author's abstract)
W90-03219

THERMALLY INDUCED DENSITY CURRENTS IN NONRECTANGULAR SIDEARMS.
North Carolina Univ., Morehead City. Inst. of Marine Sciences.
R. A. Luettich, and T. W. Sturm.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 10, p 1332-1351, Oct 1989. 8 fig, 3 tab, 12 ref.

Descriptors: *Temperature effects, *Density currents, *Lake morphology, *Cooling ponds, *Electric powerplants, *Heat flow, Mathematical models, Thermal stratification, Density stratification.

Dispersion of heat within cooling lakes, which are used to transmit the waste heat from steam generation of electric power to the atmosphere, affects the efficacy of the atmospheric transfer process, the thermal structure of the lake, and ultimately the power plant efficiency. A considerable portion of the surface heat transfer from a cooling lake to the atmosphere can occur from cooling lake sidearms, which are dead-end channels with their open end interconnected with the main body of the lake. Thermally induced density gradients are responsible for a gravitational circulation that draws heated water from the main body of the pond into a sidearm, where further surface heat transfer to the atmosphere occurs. Relations for estimating the total rate of surface heat loss and the longitudinal surface temperature distribution for sidearms of rectangular cross section have been developed. However many natural sidearms will not have rectangular cross sections. In this study, steady-state experiments in a dead-end laboratory channel having as overbank cross section are used to investigate the effects of cross-sectional shape on thermally induced gravitational circulation in cooling pond sidearms with large length-to-depth ratios. When the water depth is large over the overbank section, the flow is predominantly two-dimensional, longitudinal, and located across the entire channel width above the level of the overbank section. As the water depth is decreased, both transverse shear and density driven cross-channel circulation are observed. For very shallow water depths over the overbank section, the longitudinal circulation returns to two-dimensional circulation, although it is located only in the deep part of the cross section. Comparisons to two-dimensional theory quantitatively confirm the two-dimensional behavior at the deepest water depth and show that even at very shallow water depths the overbank section remains quite effective for heat loss. An equivalent rectangular cross section can be defined for a nonrectangular cross section which allows two-dimensional theory to be used to predict bulk sidearm properties such as total heat loss rate and return flow temperature. (Author's abstract)
W90-03220

INTERNAL LEE WAVES IN TURBULENT TWO-LAYER FLOW.
Technische Hogeschool Delft (Netherlands). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W90-03221

FREE-SURFACE FLOW THROUGH SCREEN.
Washington Univ., Seattle. Dept. of Civil Engineering.
H. H. Yeh, and M. Shrestha.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 10, p 1371-1385, Oct 1989. 12 fig, 11 ref.

Group 8B—Hydraulics

Descriptors: *Free surfaces, *Hydraulics, *Open-channel flow, *Hydraulic engineering, *Hydraulic models, *Screens, *Intakes, Cooling water, Turbines, Pumps, Forebays, Head loss, Thermal powerplants, Hydroelectric plants.

Flows through screens are of practical interest in many hydraulic engineering problems. Screens are often used to divert fish and to remove debris from an intake for a cooling water system of a thermal power plant, a turbine intake for a hydropower plant, or from a pump forebay. In spite of many applications, the hydraulics of the screen flow are not fully understood, and design criteria used in practice are not well established. In this study, a prediction model was developed for the headloss through a screen that is placed in an open channel. For a given approach-flow condition, screen inclination, and screen characteristic (for example, flow contraction and deflection caused by a screen), values of the headloss coefficient can be predicted by the model. The result shows that there is an optimal inclination angle to minimize the headloss. The predicted values of the headloss are found to be in good agreement with the measured values in the experiments. However, the minimum headloss appears to occur with slightly less screen inclination then that predicted. In addition, the headloss at the optimal screen angle is greater than the predicted value; the screen can become almost hydraulically transparent in the predicted model, but this is not demonstrated in the experiments. The headloss for the vertical screen is some what higher than the predicted value. This can be explained by the formation of flow separation near the bottom boundary behind the screen. When the screen is inclined in the flow, the flow separation is not present because of the flow deflection associated with the screen inclination. (Author's abstract)
W90-03222

OPTIMIZATION MODEL FOR WATER DISTRIBUTION SYSTEM DESIGN.
Oklahoma State Univ., Stillwater. School of Civil Engineering.
For primary bibliographic entry see Field 5F.
W90-03224

SCOUR-DEPTH PREDICTION UNDER ARMORING CONDITIONS.
Cook Coll., New Brunswick, NJ. Dept. of Biological and Agricultural Engineering.
For primary bibliographic entry see Field 2J.
W90-03225

BED-LOAD DISCHARGE OF A CHANNEL FLOW WITH WIND WAVES.
K. F. Tabukashvili.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 9, p 551-553, March 1989. 1 fig, 7 ref.

Descriptors: *Sediment discharge, *Hydraulics, *Bed load, *Channel flow, *Wind waves, Irrigation canals, Mathematical studies, Flow velocity, Irrigation canals, Bed-load discharge, Design criteria.

Deformation of the slopes of earth canals and the eolian process related to wind phenomena disturb the regime of the bed load. Consequently, when designing and operating large irrigation canals the effect of wind on the flow should be regarded as one of the main factors requiring engineering consideration when predicting the bed-load discharge and other design parameters. When evaluating the eroding or transporting ability of a flow with wind waves in canals it is necessary to proceed from the fact that the maximum bottom shear stresses are created in the case of an opposing wind in the trough section of the wave. Consequently, it should also be taken as the design value, for determination of which relation can be used as a first approximation. A mathematical relationship was developed that includes the main wind-wave parameters, with respect to which the mechanism of movement of the bed load under wind conditions is also determined. For a first approximation, this expression can be recommended as a correction factor of the bed-load discharge under natural conditions. (Geiger-PTT)

W90-03255

INFLUENCE OF RESERVOIR LOADING ON DAM STRESSES AND DEFORMATIONS.
For primary bibliographic entry see Field 8A.
W90-03325

STEPPED PROTECTION BLOCKS FOR DAM SPILLWAYS.
Moscow Inst. of Civil Engineering (USSR).
For primary bibliographic entry see Field 8A.
W90-03328

SURFACE THERMAL PLUME IN CHANNEL.
University of Western Ontario, London. Faculty of Engineering Science.
For primary bibliographic entry see Field 5B.
W90-03330

RIPRAP DESIGN.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
S. T. Maynord, J. F. Ruff, and S. R. Abt.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 7, p 937-949, July 1989. 2 fig, 3 tab, 23 ref.

Descriptors: *Riprap, *Design criteria, *Bank protection, Bank erosion, Washouts, Slope stability, Channels.

Riprap continues to be the most widely used method for protection of erodible channel boundaries. The large quantity of riprap used requires design guidance that addresses the effects of gradation, layer thickness, side slope angle, and channel bends. The applicability of riprap design in channels, natural or man-made, that are not adjacent to structures that induce high turbulence levels is analyzed. A general design procedure based on local average channel velocity and local depth is summarized as follows: 1) Determine local average velocity using the California Division of Highways equation, physical models, numerical models, or prototype measurements. 2) Determine the riprap particle size for which 30% is finer by weight. If required, make a correction for thickness, unit stone weight, or side slope angle. 3) From nearby quarries determine which of the available gradations has the lowest total cost considering cost per ton at the quarry, transportation cost, placement cost, etc.; and 4) If the gradation selected is significantly different from the assumptions used in the determination of the local average velocity (step 1), iterate. This procedure is applicable to a wide range of gradations for riprap blanket thickness equal to the maximum stone size. A safety factor of 1.2 is proposed based on a comparison with available prototype riprap stability data. Toe protection, placement method, and filter (bedding) are some of the other factors that must be considered. (Ence-PTT)
W90-03334

SPILLWAY DISCHARGE CALCULATIONS IN NWS DAMBRK.
Army Engineer Div. North Pacific, Portland, OR.
R. T. Wortman.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 7, p 976-981, July 1989. 1 tab, 8 ref.

Descriptors: *Flood waves, *Flood forecasting, *Spillways, *Weirs, *Dam failure, *Discharge hydrographs, Computer models, Orifice flow, Gates, Hydraulic design.

The National Weather Service Dam-Break Flood Forecasting Model (NWS DAMBRK) simulates an erosive dam breach with unsteady flow routing of the resulting floodwave through the downstream channel. The program is capable of simultaneously modeling a series of dams and reservoirs within a river reach, and offers several options for the computation of discharges past a dam. With this program, spillway discharges may be calculated for either an uncontrolled or a gated spillway, but not both. The discharge from an uncontrolled

spillway is strictly a function of the hydraulic head. The controlling function may by either a user-specified table of water-surface elevation versus discharge values, or a weir-flow equation. For controlled (gated) spillways, it is assumed that all gate parameters reflect uniform conditions across all spillways at the site, and multiple spillway gates are assumed to have uniform gate openings at all bays. The discharge through a time-independent gated spillway may be specified as a function of the water-surface elevation or computed from an orifice equation. The discharge through a time-varying spillway gate is calculated using the appropriate weir or orifice equations. For uncontrolled weir flow, the spillway discharge is calculated using an unsubmerged, uncontrolled weir-flow equation based on design flow and adjusted to the current hydraulic head and submergence conditions. For the transitional condition between orifice and uncontrolled weir flow, the spillway discharge is calculated for a controlled weir-flow equation. The discharge term for all turbine, leakage, fish ladder, outlet works, or other fixed flows past the dam is specified in the 'turbine flow' term which can be specified as a function of time or as a constant value until that dam fails. The current formulas included in the program should mitigate the problem of flow discontinuities arising during the transition from controlled weir to orifice flow and back, while providing fairly accurate discharge computations across all flow regimes. (Ence-PTT)
W90-03337

HYDRAULIC JUMP TYPE STILLING BASIN FOR LOW FROUDE NUMBERS.
Regional Engineering Coll., Kurukshetra (India).
N. N. Pillai, A. Goel, and A. K. Dubey.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 7, p 989-994, July 1989. 3 fig, 1 tab, 9 ref.

Descriptors: *Hydraulic jump, *Stilling basins, *Baffles, *Chutes, Froude number, Channel scour, Scour, Hydraulic design.

Design of short and efficient hydraulic jump type stilling basins for inflow Froude numbers below 4.5 is difficult because the jump formed is weak and oscillating. The performance of three stilling basins recommended for low inflow Froude numbers and a fourth stilling basin of a new design were measured. The three stilling basins studied are: 1) USBR stilling basin IV (with chute blocks and a sloping end sill, the length of the basin is equal to the length of the jump on a horizontal bed without appurtenances.); 2) the Indian Standards Institution (IS) design (which includes baffle piers as well as chute blocks and end sill); and 3) the SAF stilling basin (for use in small structures; the reduction in basin length is more than 70%.). The experiments were conducted in a steel flume with glass side panels. A false wooden floor of adjustable length and an erodible sand bed downstream were used for scour studies. The discharge in the flume was adjusted by an inlet valve so that inflow Froude numbers were 2.85, 3.75, and 4.57 in the three series of tests performed. The tests showed that even though the first two basins were much longer, they did not have any special improvement in flow conditions or in energy dissipation as compared to the SAF stilling basin. The scour observed with the SAF stilling basin was close to that observed with the IS stilling basin and better than that observed with the USBR stilling basin. The new stilling basin had wedge-shaped baffle piers of vertex angle 150 degrees cut back at 90 degrees on the sides, an apron length equal to that of the SAF stilling basin, and a sloping end sill. The sweepout depth and scour in the new stilling basin were reduced. (Ence-PTT)
W90-03339

PRESSURE RECOVERY IN DIVIDING OPEN CHANNELS.
Technical Univ. of Nova Scotia, Halifax.
M. G. Satish, A. S. Ramamurthy, and K. S. Narasiah.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 7, p 995-999, July 1989. 3

fig, 6 ref.

Descriptors: *Open-channel flow, *Diversion channels, *Bypass channels, Momentum transfer, Piezometers, Pressure-measuring instruments, Hydraulics.

A specific problem encountered in evaluating the characteristics of flow in dividing lateral open channels such as branch channel manifold systems, batteries of side weirs and systems of floor outlets is examined. In such systems, to account for the uncertainty in evaluating the axial momentum transported from the main channel to a single branch, a pressure recover factor F has to be determined. Results of a limited number of experiments are used to estimate R for the particular case of a discrete open channel branch set at right angles to a main channel. The rectangular channels used in the tests were horizontal and were made of polished stainless steel. To reduce turbulence, baffle systems were provided in the main channel. The branch channel was positioned at right angles to the main channel and the edges at the junction were sharp. The wall pressures were recorded by means of piezometers. For each experiment, the net force on the branch channel was easily computed by integrating the wall pressure readings to estimate the pressure recovery factor R. R was also independently evaluated in the traditional way using velocity and pressure traverse data in the main channel. The values of R obtained from these two methods were in fair agreement. The pressure recovery factor R remained fairly constant over a wide range of discharge ratios. The value of R did not depend significantly on the Froude number of the main channel flow approaching the branch in the range between 0.41 and 0.86. The following conclusions were drawn: (1) For spatially varied dividing flow in open channels, a pressure recovery factor R accounts for the axial momentum transfer due to the turning of the lateral flow; and (2) The value of R=0.83 was directly determined using static pressure records on the walls of the branch channel. The experimental values of R for spatially varied dividing open channel flow compare qualitatively with the corresponding value of R determined by Bajura for closed conduits. (Ence-PTT)
W90-03340

RIVER-MEANDER MODEL: I. DEVELOPMENT.
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
For primary bibliographic entry see Field 2E.
W90-03393

RIVER-MEANDER MODEL: II. APPLICATIONS.
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
For primary bibliographic entry see Field 2E.
W90-03394

DAM-BREAK FLOWS IN CURVED CHANNEL.
Snohomish County Dept. of Public Works, Everett, WA. Surface Water Management Section.
S. Miller, and M. H. Chaudhry.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 11, p 1465-1478, November 1989. 15 fig, 22 ref. NSF Grant CES-8700588.

Descriptors: *Dam failure, *Flood flow, *Flood channels, *Channel flow, *Flood forecasting, *Model studies, *Flood waves, *Hydraulic models, Mathematical models.

Experimental data on dam break flows obtained on a test facility are presented. The test facility comprises a 3.65 m by 2.3 m upstream reservoir and a 0.3 by 0.3 m rectangular downstream channel. This channel has two straight segments that are connected by a 180 degree bend. Capacitance probes are used to record water levels in the upstream reservoir. A new procedure using electronic digitization of video images is used to record water levels in the downstream channel. This procedure does not disturb flow and gives accurate results. Comparison of the unsteady water levels computed

by using the Lax scheme with the measured water levels is satisfactory. The conservation form of the St. Venant equations predicts the height and celerity of the wave better than the nonconservation form. An approximate procedure is presented to compute the lateral gradient of water surface in a curved channel. Comparison with the measured results shows satisfactory agreement. (Author's abstract)
W90-03395

MODELING OF UNSTEADY FLOW IN CURVED CHANNEL.
Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
D. C. Dammuller, S. M. Bhallamudi, and M. H. Chaudhry.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 11, p 1479-1495, November 1989. 7 fig, 1 tab, 23 ref. NSF Grant CES-8700588.

Descriptors: *Model studies, *Dam failure, *Flood flow, *Flood channels, *Channel flow, *Flood waves, *Hydraulic models, Mathematical models.

To analyze unsteady flow in a curved channel, three-dimensional equations describing the conservation of mass and momentum are transformed from a Cartesian coordinate system to a channel-fitted coordinate system. This transformation allows the use of a simple reflection boundary to simulate the walls of a curved channel. Equations in channel-fitted coordinates are then integrated over the depth to obtain a set of depth-averaged two-dimensional equations that are then solved using the MacCormack explicit finite-difference scheme. The results of the mathematical model are compared for verification to experimental data for the unsteady flow created by an instantaneous dam failure obtained in a laboratory test facility. The agreement between the computed and measured water levels is satisfactory. However, the computed wave speed is slower than the measured wave speed when the flow is near critical conditions. Reflection technique works well, except in regions close to the entrance of a bend. (Author's abstract)
W90-03396

MODELING OF RIVERBED EVOLUTION FOR BEDLOAD SEDIMENT MIXTURES.
Laboratoire d'Hydraulique de France, Grenoble.
J. L. Rahuel, F. M. Holly, J. P. Chollet, P. J. Belleudy, and G. Yang.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 11, p 1521-1542, November 1989. 9 fig, 29 ref.

Descriptors: *Alluvial rivers, *River beds, *Bed load, *Sediment transport, *Model studies, Simulation, Mathematical models, Rhone River, France.

A new computational methodology for fully coupled simulation of unsteady water and sediment movement in mobile-bed alluvial rivers was developed and tested. The one-dimensional approach treats bedload transport of non-uniform sediment mixtures with sorting and armoring effects considered. Spatial lag effects in nonequilibrium bedload transport are taken into account through innovative use of the recently developed notion of a loading law. The new system of equations for water and sediment movement is solved in a fully coupled, implicit manner using the Preissmann finite difference scheme implemented to allow for either upstream-or-downstream-induced mobile-bed perturbations. Formal analysis of the coupled system sheds new light on boundary-condition requirements for the multiple-size-class problem. The fully coupled implicit solution has proven to be robust and stable, and it respects the underlying volumetric conservation laws remarkably well, as demonstrated in continuity analyses of computed bed evolution for systematic test runs. Implementation of the new code is demonstrated through application to a schematic river reach resembling a portion of the lower Rhone River in France. (Author's abstract)
W90-03397

TURBULENT VELOCITY PROFILES FOR SMOOTH AND ROUGH OPEN CHANNEL FLOW.
Cukurova Univ., Adana (Turkey). Dept. of Civil Engineering.
M. S. Kirkgoz.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 11, p 1543-1561, November 1989. 14 fig, 1 tab, 28 ref.

Descriptors: *Open-channel flow, *Hydraulic roughness, *Channel flow, *Turbulent flow, *Flow velocity, Anemometers.

Velocity measurements, using a laser-doppler anemometer, were carried out in a fully developed, rectangular, subcritical open channel flow on smooth and rough beds. The average roughness heights of the rough surfaces, used in the experiments, are 1 mm, 4 mm, 8 mm, and 12 mm. A model is presented for determining the reference level of the velocity distribution on rough surfaces. The shear velocities are determined from velocity profiles measured close to the bed. The calculated shear velocities show an increasing tendency as the wall roughness increases. In the fully turbulent inner region on a smooth wall, the coefficients in the logarithmic law-of-the-wall distribution take values of 2.44 and 5.5; the former corresponds to 0.41 for the Karman constant. The velocity-defect expression of Coles has a profile parameter of 0.1, rather than 0.55. For rough channels, the representation of the overall data in terms of law-of-the-wall distribution seems reasonable; however, the velocity-defect distribution is not satisfactory. (Author's abstract)
W90-03398

8C. Hydraulic Machinery

ALTERATIONS IN THE FOLLOW-UP CIRCUIT OF THE SPEED CHANGER OF ERG-M TURBINE SPEED GOVERNORS FOR OPERATION IN THE ACTIVE POWER GROUP CONTROL SYSTEM.
A. A. Dekanov, N. N. Prilevskii, and V. E. Engel.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 1, p 29-32, July 1989. 1 fig, 4 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, p 33-35, January 1989.

Descriptors: *Hydroelectric plants, *Powerplants, *Electrical equipment, *Automation, *Hydraulic turbines, USSR.

One of the main problems of modern hydropower engineering is an increase of the level of automation of hydroelectric stations by introducing the unified active power group control (APGC) system. The unified APGC system is intended to operate with all types of turbine speed governors (SG). Minor alterations in the circuits of the old type of SG with magnetic amplifiers (EGR-M, EGR-2M) make it possible to connect to the APGC system. Recommendations given in previous publications are quite complete concerning adjustment and technical measures for converting the turbine SG to a follow-up device when connected to the APGC system. Alteration of the follow-up circuit of the speed changer in the EGR-M SG during operation of the units in a group control system provides the possibility of smooth transfer of the unit out of the APGC system. This procedure increases the operating reliability of the APGC system in an overcurrent control regime and eliminates emergency situations. (Fish-PTT)
W90-02560

EXPERIENCE IN THE DEVELOPMENT AND OPERATION OF A MICROHYDROSTATION.
V. N. Alekseenko, A. V. Ashmarin, and I. I. Ivanov.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 1, p 32-36, July 1989. 4 fig. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, p 35-38, January 1989.

Descriptors: *Mountains, *Water resources development, *Energy sources, *Hydroelectric power, *Hydroelectric plants, Hydraulic turbines, Live-

Group 8C—Hydraulic Machinery

stock, Farming, Hydrological regime, Field tests, Penstocks, Electrical equipment, USSR.

In remote hard-to-reach mountain regions which are rich in water resources from small rivers, the energy supply for remote-pasture livestock farming, hydrological and weather stations, geological field groups, and forestry outposts can be provided by a microhydrostation with a unit capacity of 1.5 kilowatts (type THHES-1.5), developed specifically for these conditions. The main requirements of such a system include: small capacity unit, small size and weight; simplicity of design; safety of operation; reliability of operation; convenience of assembling, dismantling, and transporting; and a minimum amount of construction work. An experimental model of the THHES-1.5 underwent thorough tests under field conditions on a mountain river at Aksak-Too in the Kirgiz SSR. The following operating characteristics were observed during the 3-yr experimental operation: number of hours of use--3,500/yr; availability factor of the unit--0.98; time of assembling and putting the THHES into operation--$<$/= or 72 hr; dismantling and preparation for relocation (with consideration of the drying o the hoses)--10-12 hr; and weight of the experimental model--92 kg. The results indicate that the transverse reaction turbine with a simplified technology of manufacturing the runner, induction motor-generator with self-excitation and a flexible hose penstock made in sections is simple and reliable in operation. (Fish-PTT)
W90-02561

SELECTION OF THE PARAMETERS OF HYDRAULIC TURBINES WHEN RECONSTRUCTING OPERATING HYDROELECTRIC STATIONS.
I. P. Ivanchenko, A. I. Nikiforov, and V. I. Platov.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 1, p 37-45, July 1989. 4 fig, 2 tab, 8 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, p 38-44, January 1989.

Descriptors: *Hydroelectric plants, *Hydraulic design, *Hydraulic turbines, Discharge capacity, Optimal yield, Dynamics, Electrical equipment, Performance evaluation, Optimization, Load distribution, USSR.

The following characteristics are typical for hydrostations where problems of the reconstruction and re-equipping of the units are urgent: the majority of hydrostations are equipped with adjustable-blade turbines, the operating regimes of which are far from the optimal efficiency with respect to the reduced discharge; at a number of hydrostations the installed capacity of the turbines has been increased by 10-25% compared with the design due to boosting the operating regime of the turbines. Along with a decrease in the efficiency of using the stream and a shift in the operation of the turbines into a zone of lower efficiency and increased dynamic loads, a decrease in the reliability of the units is observed. The need for replacement is dictated not only by physical wear of the main elements of the units but also by the fact that they have become obsolete and that the requirements imposed on hydrostations have changed. A method which enables a solution to these problems requires: (1) a complete performance curve of the turbine; (2) operating regimes of the unit in the form of a topogram; and (3) distributions for various total loads, which are found from the operating experience of hydroelectric stations in service. The proposed method of optimizing the selection of the main parameters of turbines during reconstruction and re-equipping of existing stations can be an integral part of a more general method of determining the need and sequence of modernization of the equipment of operating hydroelectric stations. (Fish-PTT)
W90-02562

EXPERIENCE IN THE START-UP AND FULL-SCALE TESTS OF THE EQUIPMENT OF THE BAJINA BASTA PUMPED-STORAGE STATION IN YUGOSLAVIA.
M. F. Krasil'nikov.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 1, p 59-63, July 1989. 4 fig. Translated from

Gidrotekhnicheskoe Stroitel'stvo, No. 1, p 54-57, January 1989.

Descriptors: *Hydraulic turbines, *Electrical equipment, *Hydroelectric power, *Pumped storage, Testing procedures, Construction methods, Reservoirs, USSR, Yugoslavia.

The first large pump-turbine motor-generator units at pumped storage stations (PSSs) under construction in the USSR are to be started and put into operation in the near future. In connection with the characteristics of the operation of such equipment related to the diversity both of the steady (turbine, pump, and synchronous capacitor regimes) and transient regimes, the completeness and quality as well as the timeliness of performing the start-up and adjustment tests and acceptance tests acquire special importance. It is of value to use foreign experience, particularly, the experience in the start-up and full-scale tests of the hydropower equipment of the Bajina Basta PSS in Yugoslavia. The start-up and adjustment works on the equipment performed after completing the installation works during construction of the Bajina Basta PSS and the numerous acceptance tests of the reversible units in all steady and transient regimes conducted at a minimum head (with initial filling of the upper reservoir to the minimum operating level) provided the possibility of successful operation of the units at the design and maximum heads. A timely check of the performance of individual components and mechanisms of the hydropower equipment and the performance of full-scale tests in all operating regimes of the units are necessary also for Soviet PSSs, which will promote the more successful start-up of PSSs. (Fish-PTT)
W90-02565

ENERGY AND HYDRODYNAMIC STUDIES OF TURBINE OPERATING REGIMES OF LARGE PUMPING STATIONS.
For primary bibliographic entry see Field 8B.
W90-02695

PROPER SECTION OF THE SUPPLY SYSTEM OF LOCKS.
For primary bibliographic entry see Field 8A.
W90-02700

TRASH RACKS WITH STATIONARY REINFORCED-CONCRETE CROSSBAR.
A. L. Rakhmanova, V. I. Platov, and I. O. Rybak.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 2, p 110-114, August 1989. 3 fig, 1 tab, 1 ref.

Descriptors: *Hydraulic engineering, *Hydroelectric plants, *Trash racks, Reinforced concrete, Flow velocity, Design criteria.

The main differences in the operating conditions of trash racks of low-head channel hydroelectric stations from the racks of deep water intakes are as follows: clogging of the racks related to poor preparation of the flooded zone; driving and heaping of logs on the racks from rafts that broke up on the reservoir; clogging of the racks by plant debris falling into the reservoir from the banks; and clogging of the racks by frazil during ice formation. The consequences of these factors are: large differences of heads on the racks; large average flow velocities before the rack; large nonuniformity of the velocities past the rack both in plan and in height, that lead to large local velocities; and large angles of incidence of the flow on the bars of the rack and considerable nonuniformity of these angles over the width of the span of the rack. The design of a rack with stationary reinforced-concrete crossbeams with some improvement of the bar sections and their attachment fittings can be recommended for further use, when this use is justified by a technical and economic comparison with the rack of the traditional design. (Mertz-PTT)
W90-02701

CAVITATION EROSION IN HYDROTURBINES.
Minnesota Univ., Minneapolis. Dept. of Civil and

Mineral Engineering.
R. E. A. Arndt, R. L. Voigt, J. P. Sinclair, P. Rodrique, and A. Ferreira.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 10, p 1297-1315, Oct 1989. 10 fig, 14 ref.

Descriptors: *Hydraulic engineering, *Cavitation, *Hydraulic turbines, *Turbines, *Hydroelectric plants, *Corrosion, Hydraulic machinery, Operating costs, Maintenance.

For many hydroelectric units, the need for repair of cavitation pitting damage to the runner, wicket gates, and other turbine components is a controlling factor in determining hydroelectric unit downtime. The increasing cost of energy that has to be generated by nonhydro sources during hydroplant downtime emphasizes the need to reduce the repair periods both in number and duration. This paper is based on a field survey of the operational and design characteristics of 729 hydroturbines installed since 1950 having either a capacity in excess of 20 MW or a discharge diameter greater than 3 m. This data base includes 67% of the total U.S. hydropower capacity (40,000 MW). A nondimensional erosion rate parameter is developed to make meaningful comparison of observed cavitation erosion rate with theory and laboratory experiments. Overall design parameters such as specific speed and unit speed for a given head are found to have little variation from manufacturer to manufacturer. However, cavitation erosion rate varies widely even when relative comparisons are made. These variations are attributable to variations in setting, manufacturing tolerances, and operational history of a given unit. Size effects appear more pronounced that predicted. Direct repair costs are only about 1.5 cents per megawatt hour, but hidden costs associated with reductions in useful life or degradation of efficiency or energy production losses could be very significant. (Author's abstract)
W90-03218

NEW INSTRUMENTS FOR ROUTINE MONITORING OF STRUCTURES AT THE SAYANO-SHUSHENSKOE HYDROELECTRIC STATION.
For primary bibliographic entry see Field 7B.
W90-03249

UPRATING HYDRO TURBINES: HYDRAULIC AND MECHANICAL FACTORS.
National Hydroelectric Power Corp. Ltd., New Delhi (India).
B. S. K. Naidu.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 10, p 19-22, Oct 1989. 1 fig, 6 tab, 5 ref.

Descriptors: *Hydraulic machinery, *Hydraulic engineering, *Mechanical engineering, *Turbines, *Hydroelectric plants, Maintenance, Upgrading, Hydrodynamics, Materials engineering, Computer-aided design, Performance evaluation, Economic life.

Hydro turbines installed 15 to 20 years ago can now be uprated by at least 15 percent through minor changes, and by about 30 percent through major modifications. These changes take advantage of recent technological innovations in engineering materials, and computer-based techniques in the hydrodynamic and mechanical design of components. Uprating options include higher outputs at rated heads, increasing the head, modifying the existing runner, and runner replacement. All the components require re-checking for their suitability, however, under the new operating conditions, and assessment of their residual life expectancy should be made. (Mertz-PTT)
W90-03305

KAPLAN TURBINE UPRATING AT THE ORLIK POWERPLANT.
CKD Blansko (Czechoslovakia).
M. Vitvar.
International Water Power and Dam Construction

IWPCDM, Vol. 41, No. 10, p 24-26, Oct 1989. 4 fig.

Descriptors: *Kaplan turbines, *Upgrading, *Hydraulic machinery, *Turbines, *Hydroelectric plants, *Czechoslovakia, Modernization, Maintenance, Cavitation, Hydraulic engineering, Cost repayment.

After nearly 30 years of operation of the Orlik powerplant in Czechoslovakia, it appeared necessary to carry out extensive repairs to components damaged by cavitation, frequent starts and considerable head variations. The opportunity was taken to uprate the equipment. To reach higher efficiencies it was necessary to use more suitable runner blade profiles, with a more favorable relationship of lift and resistance coefficients; reduce the friction losses by reducing the wetted surfaces of the runner; and achieve the optimal performance of the new runner near to the most frequent operation conditions of the plant. The modernization project has resulted in increased power production and plant availability. The final profit from the modernization is illustrated by the payback period, which, in this case, will be two to three years. (Mertz-PTT)
W90-03306

EDF'S EXPERIENCE IN THE REPAIR AND MAINTENANCE OF HYDRO GENERATORS.
Electricite de France, Paris. Service de la Production Hydraulique.
J.-M. Maujean.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 10, p 28-32, Oct 1989. 1 fig.

Descriptors: *Maintenance, *Electrical equipment, *France, *Hydraulic machinery, *Hydroelectric plants, *Testing procedures, Inspection, Economic life, Downtime, Rotors, Stators, Insulation, Hydraulic engineering, Electrical engineering, Mechanical engineering, Operating policies, Mechanical failure, Monitoring, Economic aspects.

During the normal life of a hydroelectric powerplant, the user will have to renew part of the hydromechanical and electromechanical equipment to ensure that the plant continues to operate satisfactorily. Rational use of equipment means taking full advantage of its service life and taking action (part or total replacement) at the extreme limit of this service life; it is ideal to act before an incident occurs. To allow for this, the equipment must be monitored regularly. Inspections are essential; they may require disassembly to a greater or lesser extent and, therefore, generator standstill. Inspection frequency may vary from 1-2 years for short inspections, to some 15-year intervals for the more important inspections, requiring removal of the rotor. Tests can make it possible to monitor the internal condition of insulation in the rotor and stator coils. Maintenance operations may involve total or partial removal of the stator winding with repair of the external insulation of the bars and replacement in the slot with improved wedging and reinsulation of the polar coil. The most major operation consists of rebuilding the generator. This involves rebuilding of the stator. A policy for monitoring generators will ensure improved maintenance of machinery and help avoid incidental failures. Electricite de France's (EDF) Hydraulic Generating Department has established such a policy to ensure an optimum maintenance policy at any given time. Many machines have been rebuilt and the different causes leading to rebuilding have been classified in groups. Rebuilding, when it is necessary, generally results in improved generator performances with obvious economic advantages. The policy followed so far has made it possible to keep the generators in a very satisfactory condition, in spite of the considerable age of certain plants. Experience gained through monitoring the generators has shown that incorrect application of mechanical techniques at the generator manufacturing stage, combined with inadequate monitoring of the generator, is the main cause of defects which lead to rebuilding. Although based on technical criteria, a decision to rebuild also takes account of economic factors. (Mertz-PTT)
W90-03307

UPRATING AND REFURBISHMENT IN THE USSR.
Vsesoyuznyi Gidroproektno-Izyskatel'skii i Nauchno-Issledovatel'skii Inst. 'Gidroproekt', Moscow (USSR).
B. F. Krasilnikov.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 10, p 33-36, Oct 1989.

Descriptors: *Upgrading, *USSR, *Maintenance, *Hydraulic machinery, *Foreign technology, *Hydroelectric plants, *Hydraulic turbines, Inspection, Electrical equipment, Fatigue, Feasibility studies, Hydraulic engineering.

A comprehensive study of all the hydropower plants which have operated for more than 25 years was carried out in the USSR. The analysis, carried out in 1982-1983, demonstrated that 22% of the total number of turbine failures and about 30% of generator failures had been caused by material fatigue. The results of the analysis formed the basis of a feasibility report concerning retrofitting and uprating in the European part of the USSR. Following the report, considerable work was undertaken. The retrofitting, refurbishing and extension of a number of hydropower plants, which represents considerable engineering activities, has resulted in more reliable operation, higher efficiency of units and increased capacity. (Mertz-PTT)
W90-03308

GOVERNOR UPGRADING AT THE ROANOKE RAPIDS HYDRO PLANT.
Woodward Governor Co., Stevens Point, WI. Hydraulic Turbine Controls Div.
D. L. Kornegay.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 10, p 36-38, Oct 1989. 1 fig.

Descriptors: *Hydraulic machinery, *Upgrading, *Hydroelectric plants, *Hydraulic turbines, *North Carolina, *Control systems, Benefits, Maintenance costs, Installation, Electrical equipment.

As part of a general refurbishment scheme, North Carolina Power is converting the turbine governors at the Roanoke Rapids power station to digital electronic controls. The expected benefits are: improved unit efficiency, enhanced flexibility of operation, increased reliability, and reduced maintenance costs. The installation of the new control system involved five steps: removal of the old mechanical control components; installation of the electro-hydraulic interface; installation of the electronic blade and gate servo position transmitters; installation of the new digital control equipment; and addition of electronic speed pickups on the existing permanent magnet generator. The first upgraded unit at Roanoke Rapids is scheduled to be in service October, 1989. (Mertz-PTT)
W90-03309

KARAKAYA DAM AND POWERPLANT.
9 Eylul Univ., Izmir (Turkey).
For primary bibliographic entry see Field 8A.
W90-03324

DESIGNING AERATORS FOR HIGH VELOCITY FLOW.
N. L. S. Pinto.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 7, p 44-48, July 1989. 3 fig, 5 tab, 2 ref.

Descriptors: *Hydraulic equipment, *Aerators, *Spillways, Design, Overflow channels, Mathematical analysis, Chile, Brazil, Ecuador.

Airflow through aerators has been measured in several recently built structures: the Foz do Areia and Emborcacao spillways in Brazil; the Amaluza spillway in Ecuador; the Colbun spillway in Chile; and, the Tarbela Tunnel No. 3 outlet in Pakistan. The dimensions, water flow, and aerator conditions of these structures were compared and analysed, showing the role of basic parameters in the air dragging mechanism. An empirical formula for

the performance of an aerator was derived from the Foz do Areia data. The formula, showing performance as a function of the Froude number and the ratio between the effective air duct area and the unaerated water depth of the flow, resulted in a correlation factor of 97.62 percent. It is suggested that this formula could be used for rough estimates of air entrainment at the initial stages of a project. (Ence-PTT)
W90-03327

OMATA INFLATABLE WEIR, AT THE KAWARABI HYDRO SCHEME, JAPAN.
Bridgestone Corp., Tokyo (Japan).
M. Takasaki.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 11, p 39-41, November 1989. 3 fig.

Descriptors: *Inflatable dams, *Weirs, *Hydroelectric plants, Irrigation, Water pollution control, Tidal barriers, Japan.

The design and installation of the inflatable weir used for the Omata diversion works in the Kawarabi hydro scheme is examined. Original plans called for a fixed gravity type concrete weir, but it was determined that an inflatable weir was required to prevent the village and roads above the weir from being flooded during typhoons or periods of sudden snowmelt runoff. Selection of the inflatable weir also eliminated the problem of sediment build-up behind the structure, which would threaten upstream areas, as periodic sediment flush would be accomplished during flood conditions, when the weir would be deflated and lying flat on its foundation. The rubber material used for the weir body combines a nylon material to withstand tension, with synthetic rubber for air and watertightness. In order to meet the following requirements--resistance to ozone to prevent deterioration from sun exposure, abrasion resistance to minimize wear from stones, and resistance to both high and low temperatures--a rubber weir incorporating the protective compound EPDM (ethylene propylene diene monomer) was chosen. The Omata inflatable weir is set to deflate automatically when the water level exceeds 639.8 m at the site, or when an overflow depth of 0.8 m occurs (a condition anticipated to occur twice a year). The weir is inflated manually when the water level recedes. The overflow depth for the automatic deflation system utilizes an electric water level gauge. An automatic deflation back-up system in case of power failure is provided in the form of a blow-off pipe. Based on considerations of equipment space, temperature, water quality, pipes, inflation/deflation times, installation, and maintenance, air inflation method was chosen over the water inflation method. Hydro plants represent one of the newest application of inflatable weirs. Other uses are as a diversion structure for the large quantities of water required for wet-field rice irrigation, in pollution control, and as tidal barriers because of the non-corrosive nature of the rubber body of the weir. (Sand-PTT)
W90-03390

DERIAZ TURBINE OPTIMISES ECONOMICS AT THE YASAKA SMALL HYDRO PLANT.
Mitsubishi Heavy Industries Ltd., Tokyo (Japan).
T. Tokura, and H. Matsushita.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 11, p 47-49, November 1989. 5 fig, 2 tab.

Descriptors: *Hydroelectric plants, *Turbines, *Economic evaluation, Japan.

Deriaz turbines were first manufactured for large scale projects in the 1960s. In recent years, attention has been focused on the development of these turbines for small hydro applications. A recent application of a Deriaz turbine at a small hydro plant in Japan demonstrates the advantages of these machines in achieving a high efficiency over a wide range of operating conditions. In the Yasaka plant, high grade 13% Cr-high percentage Ni stainless cast steel has been used for the runner blades (hub and cone) to reduce the need for

maintenance, thus saving labor costs. To improve cavitation characteristics, the load per blade has been decreased by the provision of ten blades. The stability of shaft vibration has been improved by decreasing the weight of the runner hub, and providing a rotary-type servomotor near the coupling which connects the turbine shaft and the generator shaft. The structure can be simplified by the provision of 16 cast stainless steel guidevanes and a single hydraulic servomotor and bell-crank system as the operating mechanism. Oil-free bearings are used for the bushes in the operating mechanism. The cast stainless steel stayring is designed for easy maintenance. The sealing system for the main shaft has special Teflon packing, which gives good abrasion resistance and is durable. The main guide bearing is of the self-contained oil-lubricated sleeve type. Cooling is achieved by a jacket on the outer circumference of the bearing, rather than cooling pipes. A comparison of the efficiency characteristics, for the normal effective head, between the Deriaz and Francis turbines showed that the Deriaz turbine had a much higher efficiency at a partial load than the Francis machine. The plant had an adequate margin compared with critical as far as cavitation characteristics were concerned. A sufficiently low water pressure value was confirmed from measurements at the casing and draft tube. No low frequency fluctuations caused by vortices in the draft tube was observed, so that aeration was not found to be required. In field tests, load rejection conditions were quite normal; no abnormal speed rise or pressure fluctuations were observed. Stable operation was achieved from no load to the corresponding maximum load at each head. Tests confirmed that the Deriaz turbine will operate normally for a wide range of operating heads. (Sand-PTT)
W90-03392

8D. Soil Mechanics

SHEAR STRENGTH OF LOAM SOILS COMPACTED BY CYCLIC LOADS.
O. A. Pakhomov.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 1, p 22-28, July 1989. 5 fig, 1 tab, 8 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, p 27-32, January 1989.

Descriptors: *Soil mechanics, *Soil physical properties, *Construction, *Compacted soils, *Loam, Moraines, Cohesive soils, Dam construction, Soil water, Moisture content, Soil compaction, Strength, Density, Rolled-earth dams, Compressibility, USSR.

When constructing dams, embankments, and other structures from cohesive soil using layerwise compaction, the material should have an optimum moisture content. Under real conditions the natural moisture content of soil is often less or greater than the optimum. An experimental investigation of two varieties of loams (moraine and blanket) was carried out to determine the effect of the characteristics of compactability (density, moisture content, cyclic loads) on the characteristics of the shear strength relevant to the method of layerwise compaction by rollers, from light to heavy. The shear strength of loams was investigated using a large compression-shear device and preliminary compacting of samples by various cyclic loads. An improved method of laboratory method was developed to determine the physical and mechanical characteristics corresponding to the technology of layered compaction of embankments by light, medium, and heavy static rollers. The regularities obtained experimentally, reflecting the dependence of the shear strength characteristics on the characteristics of compactability, must be taken into account when designing and constructing earth structures or their fragments from cohesive soils using compacting machines of various types. (Fish-PTT)
W90-02559

PREDICTION OF REWORKING OF THE BANKS OF LOWER RESERVOIRS OF PUMPED-STORAGE STATIONS.
For primary bibliographic entry see Field 2J.

W90-02693

BASIC PRINCIPLES OF THE ORGANIZATION OF SYSTEMS PROVIDING RELIABILITY AND QUALITY CONTROL OF THE CONSTRUCTION OF HIGH EARTH DAMS.
For primary bibliographic entry see Field 8A.
W90-03247

ONSITE MEASUREMENTS AND MONITORING OF THE STABILITY OF EARTH DAMS.
For primary bibliographic entry see Field 8A.
W90-03248

CAUSES OF SEASONAL VARIATIONS OF THE SEEPAGE REGIME OF EARTH STRUCTURES.
K. I. Anisimov.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 9, p 537-541, March 1989. 5 fig, 8 ref.

Descriptors: *Earthworks, *Earth dams, *Seepage, *Temperature effects, Seasonal variation, Permeability coefficient, Hydraulic conductivity, Mathematical studies, Piezometers, Hydraulic models, Piezometric head, Hydroelectric plants, Darcys law, Pressure head.

Special investigations were conducted to explain seasonal variations of the piezometric heads of dams by propagation of temperature waves. Experiments were carried out on a Darcy instrument loaded with washed river sand in a pressure flow regime. At a constant head, water with a gradually varied temperature in the range of 8-24 C was continuously fed into the instrument, which corresponds to variations of the water temperature in the reservoir. Simultaneously, measurements of the piezometric heads and temperatures were taken with a 5-min interval at the corresponding points, and the flow rate of water through the instrument was also checked. The results of a theoretical calculation made with of Hazen's formula were compared with the experimental data. Results show that variations of the temperature of the seepage flow lead to considerable fluctuations of the piezometric heads. For the permeability coefficient of the soil, length of the specimen, and gradient of the head examined in the experiments, the fluctuations of the piezometric heads were determined with consideration of an expression in cross sections of the instrument from the relation for one-dimensional pressure flow. Results were compared with data from long-term observations of piezometric heads and temperature recordings at a number of hydro developments. In both sets of results, a shift in the phases of fluctuations of the levels in the piezometers and water temperature in them and a decrease of the amplitude of the temperature fluctuations along the profile of the dam were noted. Differences in the amplitudes of fluctuation of the levels at different sites are probably related to the difference in the gradient of the head in different zones of the dam as confirmed by laboratory experiments. (Geiger-PTT)
W90-03252

GEOTECHNICAL MONITORING PROGRAMMES FOR EMBANKMENT DAMS.
J. Dunnicliff.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 11, p 12-16, November 1989. 4 fig, 2 tab, 6 ref.

Descriptors: *Earth dams, *Dam design, *Dam construction, *Monitoring, *Piezometers.

The main purpose of instrumentation in an embankment dam is to study whether or not the dam is behaving according to design predictions. Piezometers are by far the most common internal instrument used in embankment dams, serving two purposes: piezometers in a clay core indicate rates of dissipation of porewater pressure and the approach of equilibrium conditions after impounding; piezometers may be appropriate where it is desired to avoid criticism when designing a dam of conventional design and moderate height on a good foundation. There are a number of geotechnical ques-

tions to be considered in monitoring embankment dams: (1) What are the initial site conditions. These conditions are determined by use of conventional site investigation procedures, often supplemented by in situ testing; piezometers also play a role in defining groundwater pressures before construction; (2) Is performance satisfactory during construction. Instrumentation is valuable in assisting with construction control and for determining whether or not the dam as a whole is behaving according to design predictions. (3) Is performance satisfactory during first filling. Instrumentation data during first filling of the reservoir provide verification that the performance of the dam is within acceptable limits or that an unexpected event such as leakage is occurring. Effectiveness of drains, relief wells, and grout curtains can be evaluated by monitoring porewater pressures; (4) Is performance satisfactory during drawdown. Piezometers are useful for predicting porewater pressures following rapid drawdown; (5) Is long-term performance satisfactory. Measurements for monitoring long-term performance include leakage emerging downstream, performance of relief wells, porewater pressure within the embankment, vertical and lateral movements of the embankment surface, vertical and lateral deformations within the embankment, and total stress at contact between the embankment and a structure; (6) Can the state-of-the-art be improved. Instrumentation has provided, and will continue to provide, basic data for the improvement of design practices. (Sand-PTT)
W90-03386

8E. Rock Mechanics and Geology

HYDROLOGIC EFFECTS ON WATER LEVEL CHANGES ASSOCIATED WITH EPISODIC FAULT CREEP NEAR PARKFIELD, CALIFORNIA.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 7B.
W90-02577

GROUND WATER AS A GEOLOGIC AGENT.
Texas A and M Univ., College Station. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-02907

GROUND WATER AND FAULT STRENGTH.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2F.
W90-02912

GROUND WATER AND HYDROCARBON MIGRATION.
Alberta Univ., Edmonton. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-02914

STUDY OF SHALLOW SEISMICS FOR PREDICTING COLLAPSE AND CAVE IN SOIL LAYERS.
Institute of Karst Geology, Guilin (China).
For primary bibliographic entry see Field 7B.
W90-03128

APPLICATION AND DEVELOPMENT OF ELECTROMAGNETIC WAVE TOMOGRAPHY IN KARST EXPLORATION.
Beijing Computer Center (China).
For primary bibliographic entry see Field 7B.
W90-03129

AUTOMATIC TREATMENT OF PHOTOLINES.
Universidad del Pais Vasco, Bilbao (Spain). Dept. of Geodynamic.
For primary bibliographic entry see Field 7C.
W90-03130

STUDY ON THE FORMATION OF TRIASSIC 'GYPSUM-DISSOLVED-STRATA' IN GUIZHOU PROVINCE AND THE SEEPAGE PREVENTION FOR RESERVOIRS.
Water Conservancy and Hydropower Survey and Design Inst. of Guizhou Province, Guiyang (China).
W. Hu.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1117-1126, 3 fig, 2 tab, 2 ref.

Descriptors: *Geohydrology, *Karst hydrology, *Reservoirs, Seepage, *Geochemistry, *China, Groundwater movement, Karst, Geology.

After the Yanshanian movement, karstification occurring in gypsum-bearing Triassic strata formed a unique strata called 'karstic collapse breccia', secondary limestone and pseudobreccia. Human activities cause the reactivation of karstification and/or change the development direction of the karst. Development of karst, in time and space, is characterized by superposition. With the development of karstification in the same area, the variation of hydrochemical types is in an inverse order with increasing depth. If seepage prevention for reservoirs is not dealt with properly, the process of karstification will alter from mainly chemical, to chemical-physical, and finally to mechanical-destructive. Preventive measures should address requirements of the water table gradient and conditions of water circulation. Seepage prevention of the Huoshipo Reservoir, Guizhou, China, provide a typical example of this kind of prevention. (See also W90-03104) (Author's abstract)
W90-03176

STUDY OF GEOTHERMAL FIELD AND KARSTIC LEAKAGE IN KARSTIC AREA.
Guiyang Hydroelectric Inst. and Investigation (China).
C. Zou.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1127-1135, 4 fig, 1 tab.

Descriptors: *Corrosion, *Temperature effects, *China, *Geohydrology, *Karst hydrology, *Geothermal studies, Geology, Groundwater movement, Carbonate rocks, Water temperature, Graphical analysis, Mathematical studies, Ground temperature, Hydroelectric plants.

Karst development is controlled not only by carbonate lithology, structure and groundwater, but also by corrosion from water at different temperatures in the geothermal field. In power station and reservoir construction sites, there is frequently a cold water field, but occasionally, there are hot water fields as well. To research karst development and karst leakage a geothermal technique called the 'ground temperature analysis method' is used. The borehole water temperature curves are divided into five types: straight line, parabola, logarithmic curve, positive abnormal and negative abnormal. Research results are given from the ground temperature field and gradient of Naotiaohe, Jiangya and Pengshui in China and Terrio in France. On the basis of this research, two examples are discussed of ground temperature gradient analysis: (1) the Zhaixiangkou hydropower station on the Maotiaohe River; and (2) the Pengshui hydropower station on the Wujiang River. It has been proven practical to study karstic leakage by analyzing the ground temperature field. (See also W90-03104) (Author's abstract)
W90-03177

ALMOST DEVELOPED TECHNIQUE OF KARST COLLAPSE PREVENTION DURING MINE DRAINAGE.
China Univ. of Geosciences, Beijing, China.
For primary bibliographic entry see Field 2F.
W90-03180

SURFACE COLLAPSE IN KARST REGIONS.
Guilin Coll. of Geology (China).
Z. Miao.
IN: Karst Hydrogeology and Karst Environment Protection. Volume 2. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, October 10-15, 1988. IAHS Publication No. 176, (1988). p 1178-1185, 1 fig, 1 tab, 2 ref.

Descriptors: *Subsidence, *Geomorphology, *Geohydrology, *Karst hydrology, *Collapse, Karst, History, Geomorphology, Pumping, Geology, Groundwater level, Aquifers, Groundwater movement.

Collapse, a common feature of surface instability in karst regions can be classified into two types--natural and artificial. Natural collapse has been recorded since ancient times. The 19 events recorded in the history of Guangxi, China, show that collapses became more frequent and intense during the past century. Two factors which may play a role in this type of collapse are: (1) the increase of acid materials in the environment; and (2) the speed-up of water circulation. Artificial collapses are closely related to the following factors: (1) geomorphologically, they take place in negative relief areas such as depressions, basins, poljes, U-shaped valleys, broad peak cluster plains, and river terraces and graded surfaces overlying limestone basement and rarely occur in mountainous terrains and plateau slopes; (2) geologically, karst areas with thin covers composed of loose Quaternary sediments or weathered sandstone and shale, are most susceptible to collapse; and (3) geohydrologically, the covers of areas with confined karstic aquifers, which are supported by confined water, are easily collapsed when the pressure of the groundwater drops. The disturbance of man's activity may be either short-term or long-term, or repeatedly imposed. Collapse can also be either abrupt, over a long period, or multiperiodic. The key measure in preventing artificial collapse is control of the drawdown of groundwater level and pumping rate. (See also W90-03104) (Lantz-PTT)
W90-03183

FORMATION OF GYPSUM KARST COLLAPSE-COLUMN AND ITS HYDROGEOLOGICAL SIGNIFICANCE.
State Bureau of Mineral Reserves, Beijing (China).
For primary bibliographic entry see Field 2F.
W90-03184

GEOMORPHOLOGICAL APPROACH TO ENGINEERING IN KARST.
Bergen Univ. (Norway). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-03185

ANALYSIS OF THE MECHANISM OF THE SURFACE COLLAPSE IN REGIONS OF CONCEALED KARST AND CASE STUDIES OF THE FOUNDATION TREATMENT FOR BUILDINGS.
Comprehensive Investigation and Surveying Inst., EIM, China.
For primary bibliographic entry see Field 2F.
W90-03186

HYDROGEOLOGIC FACTORS ASSOCIATED WITH RECENT DOLINE DEVELOPMENT IN THE ORLANDO AREA, FLORIDA 32816.
Florida Sinkhole Research Inst., Orlando.
For primary bibliographic entry see Field 2F.
W90-03187

THERMAL WATERS IN GRANITIC TERRAINS, CASE HISTORIES FROM POLAND AND NORTH YEMEN.
Polish Academy of Sciences, Warsaw. Geological Sciences Inst.
For primary bibliographic entry see Field 2F.
W90-03193

EXPERIENCE IN SMOOTH BLASTING DURING EXCAVATION OF THE PITS FOR THE CORE OF THE ROGUN DAM.
For primary bibliographic entry see Field 8H.
W90-03251

8F. Concrete

CONSTRUCTION OF IN SITU CONCRETE-ENCASED STEEL PENSTOCKS AT PUMPED-STORAGE STATIONS.
A. A. Ravkin, and A. M. Arkhipov.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 1, p 1-4, July 1989. 2 fig, 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, p 11-14, January 1989.

Descriptors: *Penstocks, *Hydraulic design, *Hydroelectric plants, *Concrete construction, *Construction methods, Construction materials, Concrete technology, Pumped storage, Steel, Precast concrete, Conduits, Design standards, Cost-benefit analysis, USSR.

The penstocks of the Zagorsk and Kaisiadorys pumped storage stations (PSSs) were designed and made in precast concrete-encased steel. The designers were in favor of the precast variant for the following reasons: to try to reduce the volume of concrete; to try to avoid 'certain difficulties' in constructing in situ concrete-encased steel conduits, which, in the opinion of the designers, can occur when performing operations; the conviction that precisely precast members of the penstock in comparison with in situ construction provides a higher quality of manufacture and reduction of the thickness of the shell to minimum sizes; and the results of some Soviet and foreign experience in manufacturing large-diameter reinforced-concrete pipes. The technology of manufacturing in situ penstocks may also be developed. It is necessary to carry out design studies and to conduct additional scientific investigations to compare the two methods and to select one. The construction of in situ concrete-encased steel penstocks would result in accelerated construction and a reduction of labor and cost of the structure. According to design data for the precast concrete-encased steel penstocks, the cost indices of the in situ penstocks are substantially smaller. (Fish-PTT)
W90-02556

GROUTING WORKS IN THE CONSTRUCTION OF THE SIDE GROUT CURTAINS OF THE AL-QADISIYAH HYDRO DEVELOPMENT (IRAQ).
V. A. Ashikhmen, V. G. Buchatskii, N. V. Dmitriev, and L. I. Malyshev.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 1, p 47-53, July 1989. 4 fig, 2 tab, 2 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, p 45-50, January 1989.

Descriptors: *Hydroelectric plants, *Grouting, *Structural engineering, *Dam construction, *Seepage control, Earth dams, Dam foundations, Geologic fractures, Karst, Pipe flow, Planning, Drilling, Cements, Iraq.

The cutoff measures at the al-Qadisiyah hydro development, along with a deep grout curtain within the water-retaining structures (under the dam and powerhouse of the hydroelectric station with a total length of 8,920 meters), include side curtains in the right-bank and left-bank abutments to the earth dam, and are a continuation of the deep curtain in the foundation of the dam. The main purposes of the side curtains are to block possible seepage paths along the large fissures and karstic zones, to reduce seepage losses, and to eliminate their increase due to piping phenomena. It was necessary during planning and construction of the side curtains to simplify the technology of grouting and to reduce as far as possible the volumes of drilling and grouting works and the time of performing them. It was also necessary to locate reliably and fill the karst cavities and large fissures with grout along the route of the side curtains. A considerable technical and economic effect was obtained by eliminating excessive volumes of

works specified by the original design. This resulted from an analysis of the data gathered by engineering surveys, investigations of experimental grouting works, and optimization of the grouting technology. The index of unit cement absorption in the control holes was used as the criterion of grouting sufficiency on the side curtains. Grouting to eliminate karst cavities and large fissures requires the development of an industrial technology with the use of considerable volumes of grout and a large number of machines. (Fish-PTT)
W90-02563

USE OF ASPHALT MATERIALS IN JOINING EARTH DAMS.
Y. N. Kasatkin, M. Pavchich, and V. G. Radchenko.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 2, p 99-104, August 1989. 3 fig, 2 tab, 7 ref.

Descriptors: *Asphaltic concrete, *Hydraulic engineering, *Earth dams, *Rockfill dams.

Joining of earth dams, cores, and facings of earthrock dams with foundations, canyon walls, and concrete structures should be performed so that seepage strength of the soils at the contact is provided and seepage deformation of the soils in the abutment and its regression are eliminated. Special difficulties arise when dams are sited in complex engineering geological and topographic conditions, particularly in deep canyons with steep walls. Often laborious and complex works could be simplified by using hot asphalt materials. The distinctive features of hot asphalt materials are: first, the pressure in them is transmitted hydrostatically; and second, their fluidity is higher, the higher the compressive stress applied to them. All this enables them to create additional internal compression of the abutment, which not only ensures its impermeability, but also eliminates regression of the soil of the watertight element and dam in the abutment. It is natural that these conditions can be fulfilled only with the proper selection of the composition of the asphalt material for the abutment and observance of the technology of its construction. (Mertz-PTT)
W90-02699

TRASH RACKS WITH STATIONARY REINFORCED-CONCRETE CROSSBAR.
For primary bibliographic entry see Field 8C.
W90-02701

CALCULATION OF THE STRENGTH AND DESIGN OF WELDING LOOPS AND LINEAR ANCHOR JOINTS IN COMBINED PRECAST-IN SITU REINFORCED CONCRETE MEMBERS.
For primary bibliographic entry see Field 8A.
W90-02703

EVALUATION OF THE STRENGTH OF CONCRETE WITH CONSIDERATION OF ITS WORKING CONDITIONS IN A MASSIVE HYDRAULIC STRUCTURE.
V. M. Vlasov, L. M. Deryugin, V. I. Veretyushkin, and A. S. Moiseenko.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 9, p 554-557, March 1989. 4 fig, 5 ref.

Descriptors: *Concrete construction, *Concrete dams, *Concrete testing, *Mathematical models, *Hydraulic structures, Concrete technology, Strength, Compressive strength, Materials testing, Hydroelectric plants, Stress analysis, Strain measurement, Core drilling, Hydraulic engineering.

Tests of cores drilled from various depths in zones of concrete dam blocks and special investigations of the strength of large concrete cylindrical specimens performed at the B. E. Vedeneev All-Union Scientific-Research Institute of Hydraulic Engineering and abroad showed that the strength of concrete varies over the height, increasing from the top toward the bottom of the layer. An analysis of the strength of cores with a diameter of 15 cm and height of 30 cm drilled from concrete blocks of the Sayano-Shushenskoe hydrostation showed that ratio of the strength of the layer at distance h

from the top of the layer of concreting to the strength of the concrete of the upper zone of the layer of concreting was 1.18 for a layer height of about 600 mm. An analysis of the stress-strain state of models of a block showed that weaker and more deformable layers and zones of layers of concreting are confined by stronger and more rigid ones and vice versa; the stronger and more rigid layers and regions of the layers of concreting acquire additional transverse strains as a consequence of the effect of the more deformable layers of low strength. An increase of the average strength and decrease of the standard deviation of the block selected in the form of a prism with a ratio of the height to the width H/B = 4 depends on the number of layers in the model. Mathematical expressions are introduced to illustrate these principles. For concrete of the Sayano-Shusenskoe dam the value of the expected maximum acting compressive stress is 11.4 MPa. Consideration of the working conditions of concrete in a massive structure permits refining the calculated strength of concrete as a function of the quality and technology of concreting and uncovering additional reserves of strength of massive structures. (Geiger-PTT)
W90-03256

DESIGN OF PLATANOVRYSSI: EUROPE'S HIGHEST RCC DAM.
Public Power Corp., Athens (Greece).
For primary bibliographic entry see Field 8A.
W90-03388

ROLLER COMPACTED CONCRETE ARCHED DAMS.
Department of Water Affairs, Pretoria (South Africa).
F. Hollingworth, D. J. Hooper, and J. J. Geringer.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 11, p 29-34, November 1989. 6 fig, 3 ref.

Descriptors: *Concrete dams, *Roller-compacted concrete, *Arch dams, *Gravity dams, *Dam design, *Dam construction, *Dam stability, Knellpoort Dam, Wolwedans Dam, South Africa.

The Department of Water Affairs, South Africa, first used roller compacted concrete (RCC) on an experimental section in a conventional concrete gravity dam in 1979; since that time the department has designed and constructed two RCC gravity dams and one RCC arch/gravity dam. At present two more RCC gravity dams and another RCC arch/gravity dam are under construction. Initially it was thought that it would be possible to construct RCC arched dams without cracks, or that whatever cracking would take place would be insignificant in the performance of the dam, i.e. the dam would be able to adjust and close the cracks to maintain arch action. However, at this stage it is not certain that this is the case, and therefore provision must be made to control cracking, and to grout to maintain the required continuity. There is also the problem with dams that do not crack, that they may end in a state of residual tension, which is undesirable, especially in the case of seismic loading. The design and construction of the Knellpoort and Wolwedans dams has shown that the RCC arched dam is an economic and technical reality, and that it is possible to cater for, and control cracking without adversely affecting the RCC method. The RCC method is applicable to arched dams and will have a special application for high arched dams in wide valleys where the conventional arch dam tends to lose its competitiveness. The results of the instrumentation of both dams should provide valuable information for the design of RCC arched dams in the future. (Sand-PTT)
W90-03389

8G. Materials

EVALUATION OF MICROBIOLOGICALLY INDUCED CORROSION IN AN ESTUARY.
Naval Ocean Research and Development Activity, NSTL Station, MS.

B. Little, P. Wagner, J. Jacobus, and L. Janus.
Estuaries ESTUDO, Vol. 12, No. 3, p 138-141, September 1989. 5 fig, 16 ref. NORDA Defense Research Sciences Program No. 333:027:88.

Descriptors: *Pascagoula River, *Estuaries, *Sulfides, *Sulfates, *Corrosion, *Pipes, Sulfate reducing bacteria, Copper-nickel pipes, Hydrogen ion concentration, Organic carbon, Heavy metals, Dissolved oxygen, Welding, Mississippi.

A dockside experiment was designed at the mouth of the Pascagoula River in Pascagoula, Mississippi, to evaluate corrosion in welded Cu/Ni piping systems. Pipe section were examined by EDAX and scanning electron microscopy prior to exposure and after exposure. Weekly water analyses included pH, dissolved oxygen, dissolved sulfide and sulfate, total organic carbon, total suspended solids, heavy metal analyses, as well as quantification of bacteriological components. Localized corrosion was shown to be due to the following sequence of events: (1) metal segregation during welding processes; (2) settlement of sulfide-producing bacteria in welds; (3) disruption of surface films by turbulence; and (4) formation of adjacent cathodic and anodic areas. Sulfide-accelerated corrosion can occur in water with immeasurably small sulfide concentration in the presence of sulfate-reducing bacteria and sulfate in estuarine waters. Welded areas have highly irregular, porous surfaces that facilitate bacterial colonization. In anaerobic niches within the biofilm, sulfate-reducing bacteria produce sulfides. Exposure of such sulfide-insulted surfaces to fresh, aerated estuarine water results in the rapid spalling of surface deposits rendering these surfaces anodic to the sulfide-coated area. The result is accelerated corrosion. (White-Reimer-PTT)
W90-02708

CAVITATION EROSION IN HYDROTURBINES.
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
For primary bibliographic entry see Field 8C.
W90-03218

STEP-DRAWDOWN DATA ANALYSIS.
National Chiao Tung Univ., Hsinchu (Taiwan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-03226

SOFTWARE FOR INTEGRATED DAM MONITORING SYSTEMS.
Coyne et Bellier, Paris (France). Dams and Hydraulics Dept.
B. Goguel, and O. Ozanam.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 11, p 16-19, November 1989. 3 fig, 4 ref.

Descriptors: *Expert systems, *Computer programs, *Dams, *Data acquisition, *Monitoring, *Computer programs, Computers, Danjiangkou Dam, China.

An expert system, CONDORA, has been developed in France for the statistical analysis of instrumentation readings, helping the dam operator to evaluate the condition of the structure and to follow its evolution closely. The program can be connected to any manual or automatic data acquisition system. In the latter case, it gives a real-time diagnosis, which is especially valuable in the event of a crisis such as a heavy flood or an earthquake. Deferred analysis is also possible, to improve the understanding of the behavior of the structure. A special runfile of this software is currently being installed at one of China's largest dams, Danjiangkou, within an automatic monitoring system developed with Telemac, fully integrated from sensors to the analysis of readings through the collection of data by the CMO/100 central acquisition unit. (Author's abstract)
W90-03387

STUDY AND RECOMMENDATIONS ON THE SAN GERMAN VAULTED BRICK TUNNEL STORM SEWER SYSTEM.
Puerto Rico Univ., Mayaguez. Dept. of General Engineering.
For primary bibliographic entry see Field 5G.
W90-03555

8H. Rapid Excavation

EXPERIENCE IN SMOOTH BLASTING DURING EXCAVATION OF THE PITS FOR THE CORE OF THE ROGUN DAM.
A. E. Azarkovich, M. I. Shuifer, and I. L. Fedorov.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 9, p 530-536, March 1989. 6 fig, 4 tab, 2 ref.

Descriptors: *Construction methods, *Explosives, *Rapid excavation, *Rock excavation, *Dam construction, *Rock mechanics, *Rockfill dams, *Dam foundations, Dam stability, Hydroelectric plants, Ultrasonics.

The modern technology of drilling and blasting operations makes it possible to fulfill the stringent design requirements imposed on a complex configuration and preservation of the bases of cuts for the core of high rockfill dams such as the one on the Vakhsh River for the construction of the Rogun hydroelectric station. The results of smooth blasting when excavating cuts are substantially affected by natural jointing of the rock masses being excavated. The character and type of dependence of the roughness indices and number of impressions of the contour holes on the extent of natural parting were established. The smooth blasting varieties used--preliminary and subsequent contouring--provide, other conditions being equal (block structure of the mass, linear density of the charges and density between them), the same roughness indices of the slopes and, accordingly, stability of the walls of the cut. The character and type of dependence of the relative (to the average size of the natural parting) maximum range of the amplitude of roughness of the contour walls on the relative (to the average size of the natural parting) maximum range of the amplitude of roughness of the contour walls on the relative (to the size of the parting) distance between charges were established. On the basis of this dependence it is possible to determine the parameters of smooth blasting from the condition of providing guaranteed stability of the walls of the cut. Ultrasonic examination of the base of the cut showed that the state of the rock mass is satisfactory with respect to elastic deformation parameters. (Author's abstract)
W90-03251

AKIHA EXTENSION IN JAPAN.
Electric Power Development Co. Ltd., Tokyo (Japan).
For primary bibliographic entry see Field 8A.
W90-03391

8I. Fisheries Engineering

MOVEMENT AND HABITAT USE BY STREAM-DWELLING SMALLMOUTH BASS.
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
For primary bibliographic entry see Field 2H.
W90-02686

INFLUENCE OF WATER QUALITY AND SEASON ON HABITAT USE BY STRIPED BASS IN A LARGE SOUTHWESTERN RESERVOIR.
Oklahoma Univ., Kingston. Biological Station.
For primary bibliographic entry see Field 2H.
W90-02687

ENVIRONMENTAL EFFECTS ON SURVIVAL OF EGGS, LARVAE, AND JUVENILES OF STRIPED BASS IN THE CHOPTANK RIVER, MARYLAND.
Maryland Dept. of Natural Resources, Annapolis.

Chesapeake Bay Research and Monitoring Div.
For primary bibliographic entry see Field 2H.
W90-02688

CHANGES IN SALMON SPAWNING AND REARING HABITAT FROM INCREASED DELIVERY OF FINE SEDIMENT TO THE SOUTH FORK SALMON RIVER, IDAHO.
For primary bibliographic entry see Field 4C.
W90-02689

EFFECTS OF STATIC VERSUS FLOWING WATER ON AQUATIC PLANT PREFERENCES OF TRIPLOID GRASS CARP.
Agricultural Research Service, Davis, CA. Aquatic Weed Control Research Lab.
For primary bibliographic entry see Field 2H.
W90-02691

STORING SEDIMENT AND FREEING FISH.
Army Engineer District, Portland, OR.
For primary bibliographic entry see Field 5G.
W90-02734

MORTALITY ASSOCIATED WITH PHYTOPLANKTON BLOOMS AMONG FARMED ATLANTIC SALMON, SALMO SALAR L., IN SCOTLAND.
Marine Lab., Aberdeen (Scotland).
For primary bibliographic entry see Field 5C.
W90-03238

EFFECTS OF NUTRIENT AVAILABILITY ON PRIMARY PRODUCTIVITY AND FISH PRODUCTION IN FERTILIZED TROPICAL PONDS.
Pertanian Malaysia Univ., Serdang. Faculty of Fisheries and Marine Science.
F. M. Yusoff, and C. D. McNabb.
Aquaculture AQCLAL, Vol. 78, No. 3-4, p 303-319, June 1989. 3 fig, 4 tab, 58 ref.

Descriptors: *Fish farming, *Fertilization, *Tropical regions, *Fish ponds, *Nutrients, *Aquaculture, *Primary productivity, *Phosphates, Chlorophyll, Carp, Limiting nutrients, Nitrogen, Ponds, Photosynthesis.

Four species of carp were grown in earthen ponds for 352 days in three treatments. Reference ponds received no fertilizer, triple superphosphate (TSP) ponds received 5.7 kg P/ha/mo and TSP-urea ponds received 1.4 kg P and 16.6 kg N/ha/wk. Net fish production was 437 kg/ha, 1034 kg/ha and 1713 kg/ha in reference, TSP and TSP-urea treatments, respectively. Mean gross primary productivity was 0.09, 0.17 and 0.26 g C/sq m/hr and mean net productivity was 0.08, 0.12 and 0.21 g/ C/sq m/hr for reference, TSP and TSP-urea treatments, respectively. Reference, TSP and TSP-urea treatments had net photosynthesis estimated from dawn to dusk changes of total inorganic carbon of 1.04, 1.48 and 2.41 g C/sq m/day. Chlorophyll a concentrations were 12.50 mg/cu m, 46.71 mg/cu m and 109.18 mg/cu m in reference, TSP and TSP-urea treatments, respectively. Differences between treatments for fish production, algal production and chlorophyll a were significant (P < 0.05) except for net production in reference and TSP treatments. Net fish production was positively correlated to gross and net primary productivity, and chlorophyll a. Analyses of orthophosphate-P revealed that mean concentrations were highest in the TSP treatment (0.033 mg/l) followed by the TSP-urea treatment (0.009 mg/l) and the reference treatment (0.003 mg/l). An inorganic nitrogen to orthophosphate-P ratio of 36 in reference ponds indicated phosphorus limitation relative to nitrogen. A ratio of 2 in TSP ponds indicated nitrogen limitation. A ratio of 44 in TSP-urea ponds suggested phosphorus was limiting. Bioassay tests using the alga Selenastrum capricornutum Printz, supported the above contention by showing higher growth in response to phosphorus enrichment of reference pond water relative to control culture, response to nitrogen addition in TSP treatment water and response to phosphorus addition in TSP-urea treatment water. Alleviating these limitations

on algal productivity by properly designed fertilizing procedures was expected to increase fish yield. (Author's abstract)
W90-03240

LARGE CONCENTRATIONS OF SUBMERGED PULPWOOD LOGS AS FISH ATTRACTION STRUCTURES IN A RESERVOIR.
Maine Cooperative Fish and Wildlife Research Unit, Orono.
J. R. Moring, M. T. Negus, R. D. McCullough, and S. W. Herke.
Bulletin of Marine Science BMRSAW, Vol. 44, No. 2, p 609-615, March 1989. 1 fig, 3 tab, 15 ref.

Descriptors: *Reservoirs, *Fisheries, *Habitats, *Perch, *Logging, Pulp and paper industry, Maine, Rivers, Aquatic habitats.

An estimated 3.6 to 7.2 million cu m of logs (1 to 3 million cords) have sunk and created artificial habitat in the Kennebec River and its principal reservoir, Wyman Lake in Maine. The value of these logs as fish attraction structures was studied in Wyman Lake in 1979-1981. Over 1,600 fishes were collected in two collection periods: 1979-1980 using experimental gill nets; and 1981 using vertical gill nets. Five species were found in significantly higher numbers in areas with submerged logs, while yellow perch, Perca flavescens, the common species abundant in areas without submerged logs (P < 0.05). Data from 1979-1980 and 1981 suggest, however, that P. flavescens are found in equal to higher numbers in log areas in summer months and are found in non-log areas in fall. The limited use of log areas in spring by this species may be a reflection of the unsuitability of the generally non-vegetated log sites as spawning areas at that time of year. Chi square analyses indicate the sex of P. flavescens was not randomly distributed in either year. Higher numbers of males occurred in non-log areas and higher numbers of females and immature fish were found in log areas, though the differences were not as great in 1981. Studies of macroinvertebrates have shown that highest biomasses are found in the surrounding sediments rather than on the logs themselves. Thus, the value of log concentrations to fish may be more for their protective function than for their value as attachment sites for food items. (Author's abstract)
W90-03241

ABUNDANCE OF AEROMONAS HYDROPHILA L. AT LAKE HARNEY ON THE ST. JOHNS RIVER WITH RESPECT TO RED SORE DISEASE IN STRIPED MULLET.
University of Central Florida, Orlando. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2H.
W90-03242

FEASIBILITY OF CATFISH POND SEDIMENT AS A GROWING MEDIUM.
Louisiana State Univ., Baton Rouge. Dept. of Horticulture.
F. J. Sundstrom, J. E. Sedberry, and J. W. Avault.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 19, No. 1, p 117-126, Jan 1989. 3 tab, 13 ref.

Descriptors: *Catfish ponds, *Bottom sediments, *Waste disposal, *Waste utilization, *Fertilization, *Ponds, *Plant growth, *Growth media, Calcium, Potassium, Copper, Zinc, Manganese, Nitrogen, Magnesium, Feasibility studies, Pepper plants, Phytotoxicity, Fish farming.

Crop fertilization using fish pond sediments (composed primarily of menhaden fish meal, soybean meal and fish excrements) is not practiced in the U.S. as it is in other parts of the world. In commercial fish production, ponds are usually drained regularly and pond sediments removed to prevent pond aging and the development of fish off-flavors. The use of fish pond sediments has long been recognized for its beneficial effects in crop production in China and Southeast Asia. Pond sediments or 'pond mud' is allowed to dry, then removed from the pond bottom and sold as fertilizer. An

investigation was initiated to examine the feasibility of using catfish (Ictalurus punctatus) pond sediment, or pond mud, as a growing medium by examining the growth and plant nutrient content of bell pepper (Capsicum annuum L.) grown in pond mud and in a field soil. Analysis of the two media indicated that pond mud contained relatively high levels of calcium and magnesium, and had a high base saturation percentage. Phosphorus, potassium, copper, zinc and manganese levels in pond mud were comparable to those in the field soil. The organic matter level of pond sediments was lower than that of the field soil; however, pepper uptake of nitrogen was greater in the pond mud. Tissue dry weights of peppers in the field soil increased in a linear manner in response to increasing rates of fertilizer N. Fruit dry weights of peppers in pond mud, however, did not increase at N rates in excess of 84 kg/ha. There appear to be no elements at phytotoxic levels in catfish pond sediments, and pond mud was found to quite satisfactory as a growing medium. (Author's abstract)
W90-03295

RENAL LESIONS IN ESTUARINE FISHES COLLECTED FROM THE ELIZABETH RIVER, VIRGINIA.
William and Mary Coll., Gloucester Point, VA. Inst. of Marine Science.
For primary bibliographic entry see Field 5C.
W90-03445

GROWTH OF JUVENILE ATLANTIC SALMON, SALMO SALAR L., AND BROWN TROUT, SALMO TRUTTA L., IN A SCOTTISH RIVER SYSTEM SUBJECT TO COOLING-WATER DISCHARGE.
Freshwater Fisheries Lab., Pitlochry (Scotland).
For primary bibliographic entry see Field 5C.
W90-03448

9. MANPOWER, GRANTS AND FACILITIES

9D. Grants, Contracts, and Research Act Allotments

FISCAL YEAR 1988 PROGRAM REPORT (NORTH CAROLINA WATER RESOURCES RESEARCH INSTITUTE).
North Carolina Water Resources Research Inst., Raleigh.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109455/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G1508-01, May 1989. USGS contract 14-08-0001-G1508. USGS Project G1508-01. 24p.

Descriptors: *Water resources institutes, *Training, *Research, *Information transfer, *North Carolina, Education, Projects.

The North Carolina Water Resources Research Institute program for 1988-89 (Federal Fiscal Year 88) focused on several research areas of high priority for the state and southeast region: water supply, waste management, surface water quality, groundwater and technology transfer. Support from the U.S. Geological Survey through the Water Resources Institute Program (WRIP) was supplemented by the Urban Water Consortium, contracts with the North Carolina Department of Natural Resources and Community Development and with the U.S. Environmental Protection Agency. A high level of university support continued. A total of twenty-two research projects were funded with these combined resources. Three WRIP research projects were supported in FY 88. One evaluates

soils and saprolite in the Piedmont Region to assess the movement of various pollutants, especially those found in domestic wastewater and landfill leachates, another examines the role of wetlands in removing nutrients from streams receiving wastewater discharges, and the third will determine the effectiveness of vegetated buffer areas in removing sediment and phosphorus. The information transfer program for the Institute focused on emerging water resources issues and used the following strategies: (1) reviewed and published reports; (2) research reviews; (3) published a bi-monthly newsletter; and (4) organized and cosponsored eight workshops and conferences. (Lambert-UNC, WRRI)
W90-03548

FISCAL YEAR PROGRAM REPORTS (NEW JERSEY DIVISION OF WATER RESOURCES).
Rutgers - The State Univ., New Brunswick, NJ. Center for Coastal and Environmental Studies.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109463/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G157701, 1988. 16p, 2 tab, USGS Contract 14-08-0001-G-1577. USGS Project G1577-01.

Descriptors: *Research, *Information transfer, *Administrative agencies, *New Jersey, *Training, Education, Projects.

The 1988 New Jersey Section 104 program focused on three major issues currently facing the state: contamination of groundwaters by organic contaminants; acidic deposition, and the fate of heavy metals in soil systems. Two projects assessed the fate of contaminants in surface and groundwaters: (1) an investigation of the transport and conversion of organic contaminants in sub-surface systems and (2) an assessment of the mobility of lead and cadmium in soils. Two additional projects addressed acidic deposition, with one measuring volatile reduced sulfur compounds in the acidic New Jersey Pinelands and a second assessing the influence of aquatic macrophytes on water quality parameters in a small acidic lake. (McIntosh-Rutgers U.)
W90-03549

FISCAL YEAR 1988 PROGRAM REPORT (DELAWARE WATER RESOURCES CENTER).
Delaware Univ., Newark. Water Resources Center.
R. D. Varrin.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109471, price codes: A03 in paper copy, A01 in microfiche. Program Report G1553-01, July 1989. 21p. USGS Project G1553-01.

Descriptors: *Water resources institutes, *Delaware, *Research, *Information transfer, *Training, Education, Projects.

The Fiscal Year 1988 Delaware Water Research Institute Program focused on three critical water problems of the state and region: contamination of groundwater, groundwater use, and sedimentation. Three projects developed information needed by water planners, managers, and users for the protection and maintenance of Delaware's groundwater supply. Included are methods for cleanup of toxic organic compounds and petroleum products, a computer model to provide for cleanup of toxic organic compounds and petroleum products, a computer model to provide detailed qualitative information on how landfill practices influence leaching volume, and enhancement of microbial degradation of recalcitrant and refractory organics by pre-oxidation. A fourth project described and compared water table regimes of selected soils to

determine the relationship between soil morphology and water regime--important information for those evaluating sites and designs for septic tank absorption fields. The final project studied the natural removal rate of zinc-contaminated sediments from a creek, as such sediments pose a pollution threat to water supplies. (USGS)
W90-03550

FISCAL YEAR 1988 PROGRAM REPORT (SOUTH CAROLINA WATER RESOURCES RESEARCH INSTITUTE).
Clemson Univ., SC. Water Resources Research Inst.
P. B. Zielinski.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109489/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G1588-01, June 1989. 44p, 12 ref. USGS Contract 14-08-0001-G-1588. USGS Project G1588-01.

Descriptors: *Water resources institutes, *South Carolina, *Research, *Information transfer, *Training, Education, Projects.

Included in this report are sections on the water problems and issues of the State, the goals and priorities of the total program, the synopses of the program projects and information concerning the information dissemination program. The synopses contain information regarding research projects funded by the Water Resources Research Institute including: (1) Thomas Overcamp studied the first phase of a project involving the fate of volatile liquids in downward transport through the ground; (2) Predicting the future fate of PCB's in Lake Hartwell and the effects of proposed remedial actions is under current study by Alan Elzerman; (3) The complex nature of the multiphase transport behavior of flow of hydrocarbons in porous media is under current study by Kevin J. Farley; (4) In an attempt to understand better the hydrogeology of unsaturated Piedmont saprolite, a study was conducted by Richard K. White; and (5) Ben L. Sill completed an analysis of groundwater contaminant transport with three dimensional scaled models. The Information Transfer Program currently in effect is briefly discussed. (Zielinski-Clemson U., SCWRRI)
W90-03551

10. SCIENTIFIC AND TECHNICAL INFORMATION

10B. Reference and Retrieval

HYDROGEOLOGIC CORRELATIONS FOR SELECTED WELLS ON LONG ISLAND, NEW YORK--A DATABASE WITH RETRIEVAL PROGRAM.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-02862

10D. Specialized Information Center Services

DESCRIPTION OF DATA FILES COMPILED FOR THE CENTRAL MIDWEST REGIONAL AQUIFER-SYSTEM ANALYSIS.
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 7B.
W90-02852

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W90-02902   2F

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W90-03061   7C

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W90-02619   5B

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